Popular Science®

The What's New magazine

$1.50
NOVEMBER
1980

DO WE NEED THE BREEDER REACTOR?

Hand-held computers

Ford Granada 1981.
Built for a changing world. Designed with a commitment to quality.

In a world calling for change, no American-built sedan has changed more for 1981 than the new Ford Granada. Count the ways:

Granada is smaller than last year.

Granada has more interior room than last year.

Granada has rack-and-pinion steering this year.

Granada has a new type of suspension for this year.

And, best of all, Granada's efficient 4-cylinder engine for 1981, combined with its new sleek aerodynamic styling, gives it the best mileage in its history—21% better than last year!

23 EPA EST MPG 34 EPA EST HWY

For comparison. Your mileage may differ, depending on speed, distance and weather. Actual highway mileage and California ratings lower.

Granada is built with Ford's attention to detail. Every seat is fitted by hand and every door is adjusted by hand. Every car is examined by at least 38 quality-control inspectors. That's attention to detail you can see, feel and hear.

Your Ford Dealer can discuss buy or lease arrangements and tell you about Ford's Extended Service Plan.

FORD GRANADA

FORD DIVISION

The New Ford Granada

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In these days of computerized circuits and quartz crystals, virtually anyone can put a clever watch on your wrist. But if you want solid construction and unusual styling to go with all that genius, that's a lot to ask.

Yet now comes a timekeeper with rare intelligence, in a package that's just as exceptional.

And at a price that's irresistible.

It's new from Xernus (zer'nus): the solar musical alarm chronograph. Available now, for just $89, through The Sharper Image.

15 second serenade from a 5 mm profile.

No comparably equipped timepiece on earth can match the slimness of this new Xernus.

To give you an idea how flat its 5 mm case really is, one competitor actually devoted part of a recent ad to crowing over the "thinness" of *their* chrono; it measures 8.9 mm—nearly twice as thick as the watch you're looking at.

One reason for the uncommonly lean appearance of Xernus is its solar assisted micro-thin battery (available at most jewelers). By turning to solar cells—sensitive to sunlight or even dim room light—Xernus engineers found a way to extend battery life to two years or more.

They also discovered how to make the traditional wake up/appointment alarm infinitely more interesting. By replacing beeps and buzzes with a classical symphonic melody: *Bridge on Avignon* (until now, putting a maestro on your wrist meant wearing a very chunky watch).

These same wizards squeezed in a lot of other timing talents.

Like ± 15 second-a-month quartz accuracy.

A day/date calendar.

A remarkably thorough stopwatch.

And two-zone timekeeping (for complete description of all functions, see face diagram).

Water stays out. Compliments pour in.

It's surprising how many brainy watches rely on materials that just aren't reliable. Like plated base metals that pit at the first sign of routine moisture, and plastic face crystals that quickly scratch.

But Xernus' case and band are machined from 100% solid stainless steel. And it's backed by a water testing program that insures—in fact guarantees in writing —that your Xernus can safely be immersed in water 60 feet below the surface. (Others only claim "water resistance," which means virtually nothing.)

Xernus' face crystal, by the way, is rock-hard tempered mineral glass—not plastic. Inside the crystal is mirrored face plating (an expensive technique), framing the LCD display in gleaming gold and silver.

This unusual timepiece has yet another striking feature: styling that's a challenge to the rest of the digital world. Its octagonal crystal is firmly set in a brushed-finish stainless case, then framed by four recessed screws—each smothered with ten microns of real gold.

A reputation grows.

You may already be familiar with Xernus. For several years, we've been snatching up their timekeepers as fast as they can produce them.

And it still amazes us that they can consistently create one unusual chronograph after another. In addition to letting us pass on their most exceptional genius yet —for a startling $89. (The same model, covered from case to clasp with real gold—not "gold-tone"—is just $109.)

Best of all, we'll give you the opportunity to see and listen to this Xernus yourself, before making a final commitment. If not delighted, return the watch within two weeks of receipt (in new condition, please); The Sharper Image will refund your entire investment, including delivery charge.

Xernus comes with full instructions, service-by-mail (if needed), battery in place and a one year warranty.

ORDER TOLL FREE.

For Xernus in Stainless, please order product #292 for $89; for Gold, order #291 for $109. Add $2.50 delivery. Plus $5.34 and $6.54 sales tax, respectively, in California. Credit card holders may use toll free numbers, or send check. Please mention this magazine.

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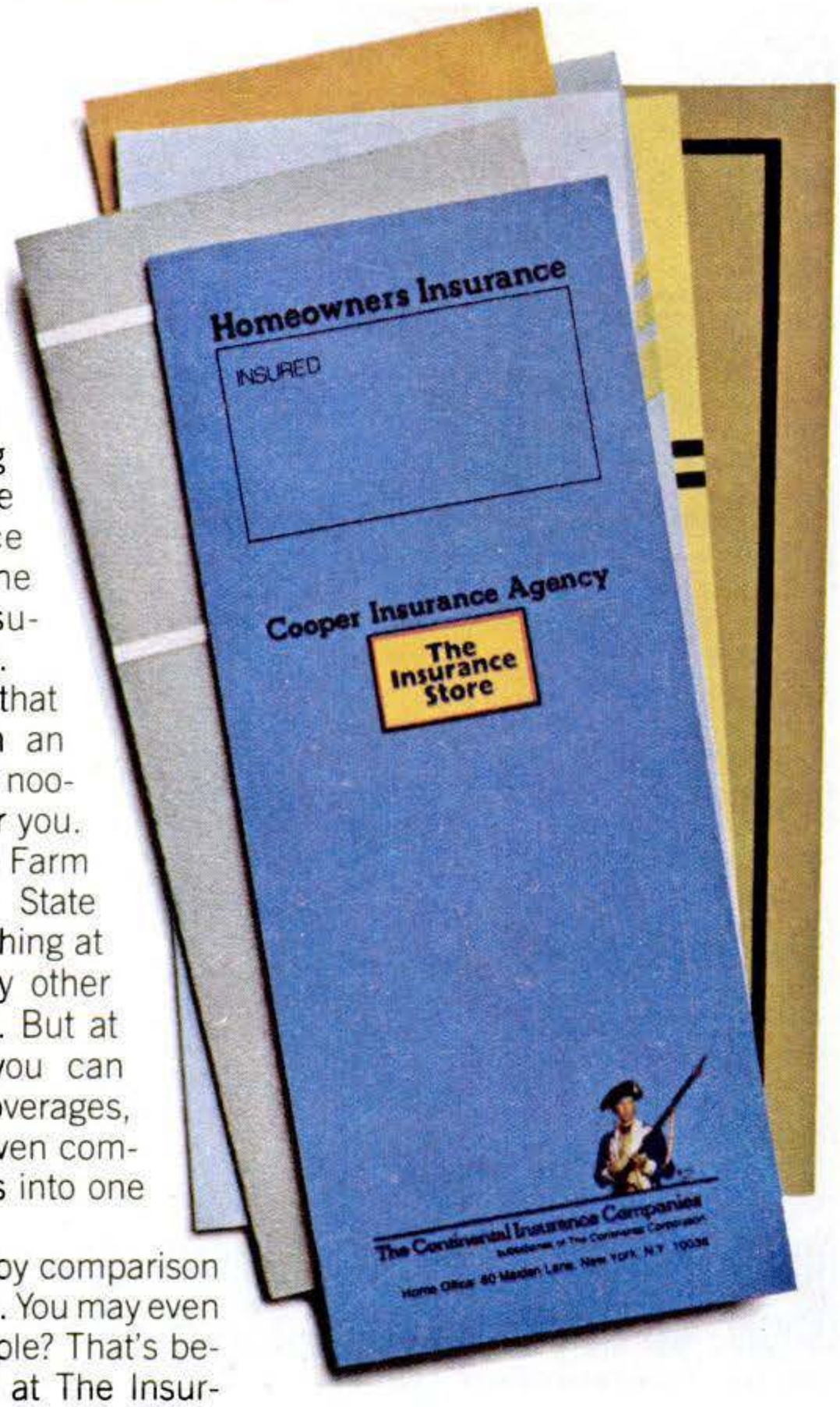
COMPARISON SHOPPING. IT'S EASIER AT THE INSURANCE STORE.



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BUZZ BOX

My wall timers were great for the first year. Then a strange thing happened.

By Joseph Sugarman, President
JS&A Group, Inc.

This advertisement is about a few wall timers I installed in my home. I expected them to automatically turn my lights on and off and make my home appear lived-in, even when I wasn't at home.

But I was in for a surprise. The timers started to buzz. Not loudly, at first, but still very noticeably. Then, after a few months, they started buzzing more loudly. And finally a few of them pooped out completely.

ABSOLUTELY SILENT

No wonder. The timers I bought were mechanical devices with a motor and moving parts that switched on and off every 24 hours. In time, the parts aged and buzzed as they wore out. Eventually, they went out completely. I called my light timers, "Buzz Boxes" and knew the electronic revolution was not far behind with a silent and more dependable unit that would do a lot more.

Last month Dynascan Corporation contacted me with a new wall timer which they called the "Night Sentry." This one was totally solid state, no moving parts and above all, absolutely silent. But there were a few pleasant surprises.

LIVING PATTERN PROGRAM

The Night Sentry is very easy to program. Just turn a dial to the time (an AM or PM indicator appears) and press a button which turns on the light. Set the time you want the light to go off and press the same button to turn the light off. Keep repeating this process and the Night Sentry will remember the entire program and repeat it for you in silent accuracy year after year after year.

You can also program it in its 'living-pattern' mode. Simply turn your lights on and off throughout a typical day as you normally do. After 24 hours the Night Sentry will remember the exact pattern and your timer will operate your lights just as you yourself did—all automatically.

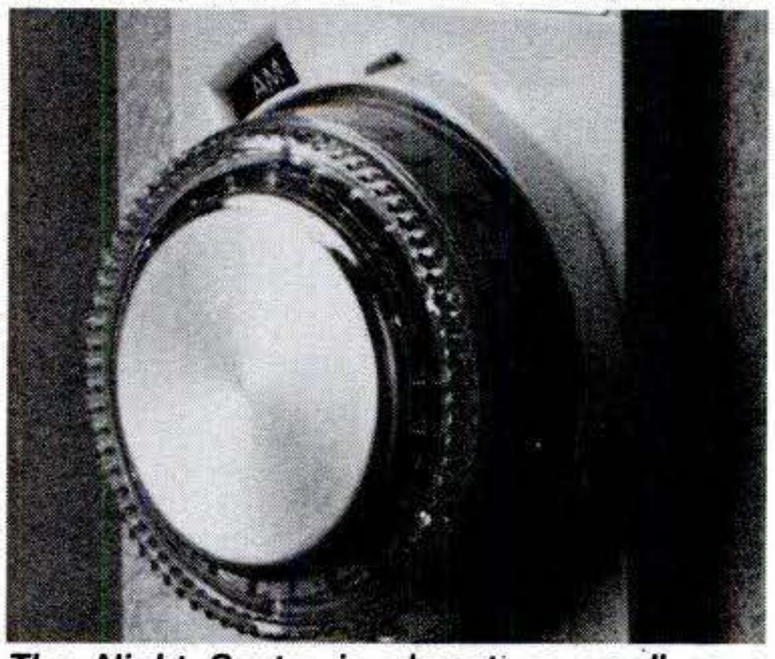
LONGER BULB LIFE

If by chance you have a power failure, the Night Sentry will keep its memory for at least 5 minutes. Since most power failures are momentary, you won't have to reprogram it. But if the power failure is longer than five minutes, when the power does come back on, your lights will remain in their off position.

The Night Sentry has a unique feature that in time could actually pay for the unit. Most bulbs burn out because the power surges each time a bulb is turned on. These power surges weaken a bulb. The Night Sentry has a built-in 'soft start' system that eliminates the surge and thus your bulb will last up to three times longer than its normal life. This is a very important feature for outdoor lighting where bulbs are often more difficult to change and seem to always go out in the dead of winter.

BATTLESHIP CONSTRUCTION

When Dynascan Corporation developed the Night Sentry, they decided to go overboard and produce a product that far exceeded standard specifications. For example, the Raytheon Triac used in the system was designed for 220-volt products—not just your standard 110-volt wall switch. There are transient surpressors built to take a voltage surge of up to 2500 volts—in short the Night Sentry was built like a battleship.



The Night Sentry is almost as small as a typical light switch so you could even install two of them in a double gang wall plate.

Even if you've never installed a light switch in your life, you'd find it a snap to install the Night Sentry. Just turn off the power at your fuse box, connect two wires by twisting them together and screw the Night Sentry into your old electrical box. Installation takes less than five minutes and you use the same wall plate you had on your switch before.

I have recently replaced all of the timers in my home. I even added a few in places like my bedroom so that all my lights turn on when it's time to get up. I don't need an alarm clock now. My outdoor and indoor lights are now silently and efficiently controlled, and my house looks lived in even when I'm away.

TRY ONE OUT

We urge you to order a Night Sentry for only **$29.95** plus $2.50 for postage and handling (Illinois residents add 6% sales tax) or order two for $55 plus $3.00 postage and handling. Credit card buyers may call our toll-free number below. We'll send you a Night Sentry solid-state timer complete with easy-to-install instructions and a one-year limited warranty. There is also a three-way switch timer for $5 extra per unit.

Then use the Night Sentry for a month. Program it. See how silently it operates and then order more for the other rooms in your house. If, however, you're not completely satisfied, return your unit within 30 days for a prompt and courteous refund, including your postage and handling.

I can personally recommend the Dynascan Night Sentry timers. I have them throughout my home and my friends have them too. They really add to our security and peace of mind and I urge you to at least order one at no obligation, today.

JS&A®

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The What's New magazine

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Beep Free

Doctors use them and so do many businessmen. The pocket beeper now takes a giant step forward with the introduction of the own-your-own system.

You're away from your desk in a meeting. Suddenly your pocket beeper starts beeping. You pull it out of your pocket, press a button and you hear your secretary's voice with a message.

"Big deal," you say. "What's so special about that. There are thousands of pagers like it in use." Yes, but this one is different.

TOTAL CONTROL

In the first place, you own the entire system. You own the transmitter and the beepers. Secondly, the system is inexpensive. It costs less than leasing one traditional beeper for a year. And finally, it solves the problems that other pagers can't solve—but more on that later.

The new Auto Page paging system consists of a transmitter that sits on your secretary's desk. When a call comes in, she presses a button which sends out a signal to your paging device. The antenna rests on your secretary's file cabinet and plugs easily into the transmitter so there's no installation.

MAKES NO SENSE

But like many breakthrough products the Auto Page System has limitations. The system was designed for office, factory, farm or home use. So its range is limited to one mile with voice and two miles with tone.

For doctors who are constantly on the road, the Auto Page does not make sense. For the business person, however, who moves frequently through an office or factory, the system is ideal.

Instead of using expensive paging or loud speaker systems, you can locate and communicate with your staff in privacy no matter where they are within your premises.

SERIOUS THOUGHTS

You can use up to six different pagers, each on different channels, and the entire system with two beepers costs only $395.00.

Once you own the system there are no further costs. Conventional pagers rent for up to $25.00 per month so in eight months the Auto Page System with two pagers would pay for itelf and from then on your secretary can literally 'beep free.'

Each additional beeper costs $75.00 or the equivalent of a three month lease on the typical beeper. But you can't compare a typical beeper with the Auto Page. The Auto Page has voice transmission. The typical beeper does not. The Auto Page is a totally personal system that can be used anywhere. The typical beeper must be used near a big city. And finally, the typical system is expensive—many times the cost of the Auto Page System.

HERE AND THERE

We suggest that before you decide to purchase, you experience the freedom and convenience of personal paging. Order a system from JS&A on our 30-day trial. Give a beeper to each member of your staff. See how easy it is to set up a system (just plug it in). And then actively use it for a month. If personal paging is not the most convenient and efficient way to communicate, return it anytime within 30 days for a prompt and courteous refund.

We've tested our system at construction sites, in large buildings, on farms, in the country, with motel operators and several small businesses. Based on our personal observations and sales success, we are convinced that the Auto Page System of personal paging is the future of paging.

JS&A is America's largest single source of space-age products—further assurance that your modest investment is well protected. Service should not be required for many years as the Auto Page is totally solid state, but if service is ever required, just pop your receiver or transmitter in its mailing carton and mail to the Auto Page service-by-mail center which will promptly repair and return your unit.

To order your system, send your check or money order for **$395.00** for a system with two beepers and $75.00 for each additional beeper up to six (Illinois residents add 6% sales tax) to the address below. Please add $4 for postage and handling. Credit card buyers may use our toll-free number below.

We'll send you a transmitter, antenna, beepers, one-year limited warranty and complete instructions.

Personal paging and low-cost personal communications are nicely packaged in a system that will make your company more efficient from the very first day you test our system. Order one for your test at no obligation, today.

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PS READERS TALK BACK

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VW's stepless transmission

In "VW's Stop/Start 21st-Century Car" [PS, July], you stated that VW is working on a stepless drive system based on the principle of a chain running between variable-diameter, double-cone pulleys. Is this the same as the van Doorne Transmatic CVT in the June issue?

Vincent J. Cinquegrani
Phoenix, Ariz.

Jan Norbye replies: "No, it is not the Transmatic. Volkswagen did not show me the experimental transmission, but from a verbal description I got the idea that it's based on the type of chain drive you find on lathes and other machine tools, scaled and adapted for automobiles."

Shooting in the dark

The optical-fiber camera you recently described [PS, Sept.] has an interesting predecessor: the original Olympus Gastro Camera. Though it did not use fiber optics, its operation was quite similar to that of the camera you describe. Since the camera operated within the body's internal darkness, the operator would aim the camera by dimming the room lights and triggering the flash. One could tell which part of the patient the flash was aimed at by noting which part lit up.

Ivan Berger, New York, N.Y.

Warming up the "Y"

Your item about geothermal space heating at the YMCA in Klamath Falls, Ore., in "PS/What's News" [PS, Aug.] contained an error. We did the engineering design work on this project. It was designed with a 35-deg.-F temperature differential between the geothermal supply and the discharge off the heat exchanger for a 4,375,000 Btu/hr utilization at peak load. A five-degree differential, as you indicate, would not be an economically feasible system.

James K. Balzhiser, President
Balzhiser/Hubbard & Assoc.,
Eugene, Ore.

C. P. Gilmore replies: "Not only did I goof on the temperature differential; as several readers pointed out, I also left the impression that this was the first successful geothermal space-heating project ever completed. Of course, this is not the case. What I meant to say was that this is the first successful operation under the Dept. of Energy's $25 million geothermal demonstration program."

Highway robbery

Your article, "The Shaky Reliability of Police Radar" [PS, Aug.], was very timely for me. I recently traveled from New York to California and back with a Fox radar detector. With it, I found out just how inept policemen across the country are at handling radar. I saw them trying to use it on jammed freeways during rush hours, pointing it directly into hills, pointing it off the road, and using it on busy city streets where there is a lot of interference. If police are going to continue using radar, they are going to have to learn to operate it properly.

[Name withheld], Hilton, N.Y.

I was trapped by a questionable procedure used by an Ohio highway patrolman on Interstate 71 near Medina, Ohio. He was southbound and I was northbound when he aimed the radar in my direction, shooting under a steel and concrete viaduct. I had the cruise control set and operating at 55 mph. He claimed the radar clocked me at 67.

Thomas M. Barnes, Gahanna, Ohio

I received a radar citation on I-55 in southern Illinois. I was among a group of cars all traveling at the same speed. The state trooper followed us for about a half mile before pulling only me over to the side of the road. Too bad I had Louisiana plates while the others had Illinois plates.

A. L. Barcelona
Metairie, La.

State Route 404 on the eastern shore of Maryland is a two-lane road, and traffic is always bumper to bumper at 5 p.m. My wife was doing 50 mph, just like the rest of the traffic, yet a trooper coming in the opposite direction waved us over and gave us a ticket for going 64 mph. We would have had to fly over the tops of the cars in front of us to go that speed.

Christian Kurrle, Severna Park, Md.

More on supercarbs

Re James Forry's letter about "100-mpg carbs" [RTB, July], I would say that 25 mpg was excellent mileage on a '41 V8 Buick, considering that Buick didn't build a V8 engine until 1953.

George Whitelaw
Langley, B.C., Can.

Make-it-yourself bike gear

I was surprised not to see Frostline mentioned in your July story on bicycle accessories. In the past year, I've made a tent, two sleeping bags, a knapsack, and more bicycle bags than I can count from Frostline unassembled kits. They're about half the cost of Kirtland's products, fun and easy to put together, and you can put in extras the ready-made's never think of.

Vicki K. Baker, Wichita, Kans.

Corrections: Contrary to our report in "PS/What's News" (July), the California Air Resources Board has not made a final evaluation of the Zemco Fuel Saver. Although the stop/start device passed the dynamometer emissions test, CARB has determined that under certain conditions it could cause an unsafe driving condition.

In our bicycle-gear story (Aug.), the rear-view mirror clipped to the cyclist's helmet is incorrectly identified. The mirror is manufactured by David A. Poor Bicycle Services.

The address given for the plane kit in August's "What's New" was incorrect. For information on the Hummer plane, write to Michael Markowski, Box 4371, Harrisburg, Pa. 17111.

We also erred in "What's New in Boating" (Aug.). The hardy new canoe is made by Midwestern Fiberglass Products (Box 247, Winona, Minn. 55987).

Finally, our PS leisure home plan for September ("Earth-Sheltered Sod-Roofed Home") contained two errors. The south-facing glass wall is 60 feet long, not 64, as stated. Also, the architect's drawing shows a 16-foot-wide living space, but it is labeled as being 20 feet. Architect Woods advises us that the house can be expanded to 20 feet, but at greater expense than the $25 per sq. ft. quoted in the article. Write to him for details. PS

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Rolex owners have grown accustomed to prices that begin at $500. And if you're considering a Rolex with any gold in it, you can figure to spend $2000 or more.

To justify touching the stratosphere, Rolex delivers an irresistable mixture of legend and quality. With solidness approaching the Rock of Gibraltar, certified Swiss chronometer accuracy, and a reputation for durability, this prestigious name has continued to maintain a position of high esteem.

And as if quality alone weren't enough, it also bestows upon its possessor that sure distinction usually reserved only for Rolls Royce automobiles—visual confirmation that its owner has arrived.

Why everybody's switching to quartz. Even Rolex™.

Quartz crystals are far and away the most accurate timekeeping element the world has ever known.

That's why the finest movements depend on quartz vibrations (32,768 per second). And why even Rolex, an acknowledged pioneer in mechanical "mainspring" watches, is now turning to the more reliable quartz precision.

How reliable? The watch pictured below guarantees ±5 second-a-month accuracy—exceeding the highly regarded Swiss Chronometer standards. Its Swiss made movement utilizes the most advanced solid state technologies. And the most proven quality assurance known to man: Swiss pride.

Because of its up-to-the-minute electronic circuitry, this same timepiece should never need cleaning, oiling or repair work. Just a battery change every 18 months or so (and any jeweler can do the job).

But in case you haven't noticed, this extraordinary timekeeper isn't a Rolex. It's a Realtime.

Not just a copy. A commitment.

While its design is an unmistakable tribute to the prestigious Rolex look, this Realtime introduces some pleasing innovations (the case, for example, is thinner and more compact than the Rolex).

But for the most part, Realtime's skilled casemakers were committed to faithfully reproducing the original design—detail for detail. From the stylized gold bezel to the supple link bracelet to the magnifying date window on the crystal.

A water-tight screw-down setting stem—usually found only on the most costly watches—is just one reason why Realtime guarantees underwater protection down to 165 feet. And why you'd expect this prestigious looking timekeeper to cost a lot more than it does.

These same demanding standards are reflected in Realtime's superb construction. To prevent tarnishing or scratches, both case and bracelet are machined from solid stainless steel (please don't confuse this with less expensive "silvertone" finishes). The classic analog hands and dial are coated with tritium for easy visibility, even at night. And the setting stem, similar to the Rolex, features a screw-down locking mechanism—the same water-tight design found in submarine hatches.

Add to that a tightly sealed case and crystal, and it's no wonder Realtime guarantees water protection to 5 atmospheres (165 feet below the surface). The same underwater depth as many Rolex models.

How Realtime saved you $1850.

In days when only a master watchmaker's skilled fingers could create a high caliber timepiece, a lofty price tag was understandable.

But today's computer-engineered electronic movements have made perfection possible at a much lower price. Selecting the finest of these movements (made in Switzerland), Realtime dramatically reduces labor costs by assembling the watch in Taiwan—where handwork, still considered an art, is also (by European standards) a bargain.

And instead of inflating the price by using solid gold, they have selectively plated the links, bezel and hands. By the way, those rich 5 microns of real gold are enough to preserve the lustrous look, even after years of rugged wear.

So how much did Realtime's cost-cutting measures save you?

Remarkably, the watch you're looking at sells for only $149.

And it can be yours with the ease of a free phone call. But to avoid disappointment, please order early; our supply is really quite limited (initial production run is only 500 units). You must be solidly convinced that your new Realtime is an excellent investment. If not, return it within 2 weeks of receipt for a prompt, courteous refund. Watch comes complete with battery in place, one year warranty, convenient service by mail, gift box and full instructions.

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Order product #247. Credit card holders may call our toll free number anytime. Or send a check for $149 plus $2.50 delivery. Add $8.94 sales tax in California. Please mention this magazine.

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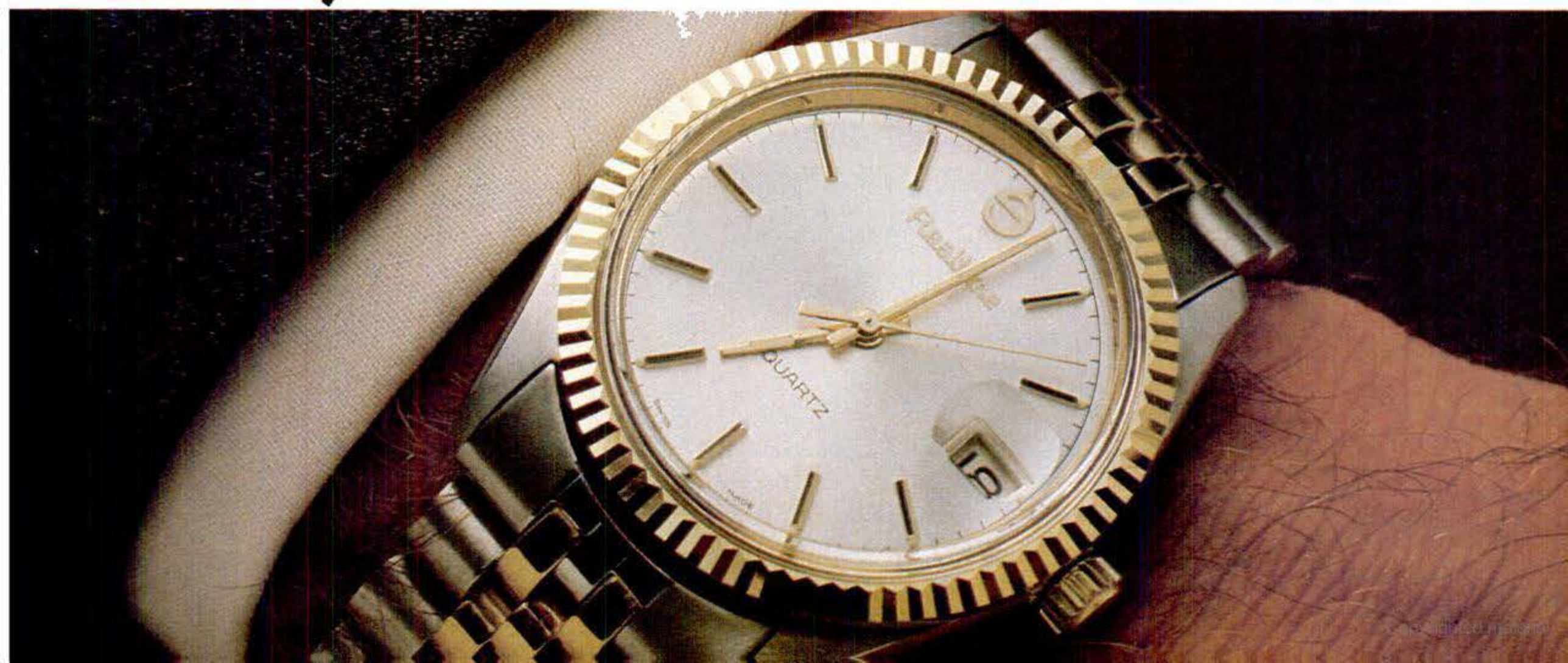


Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

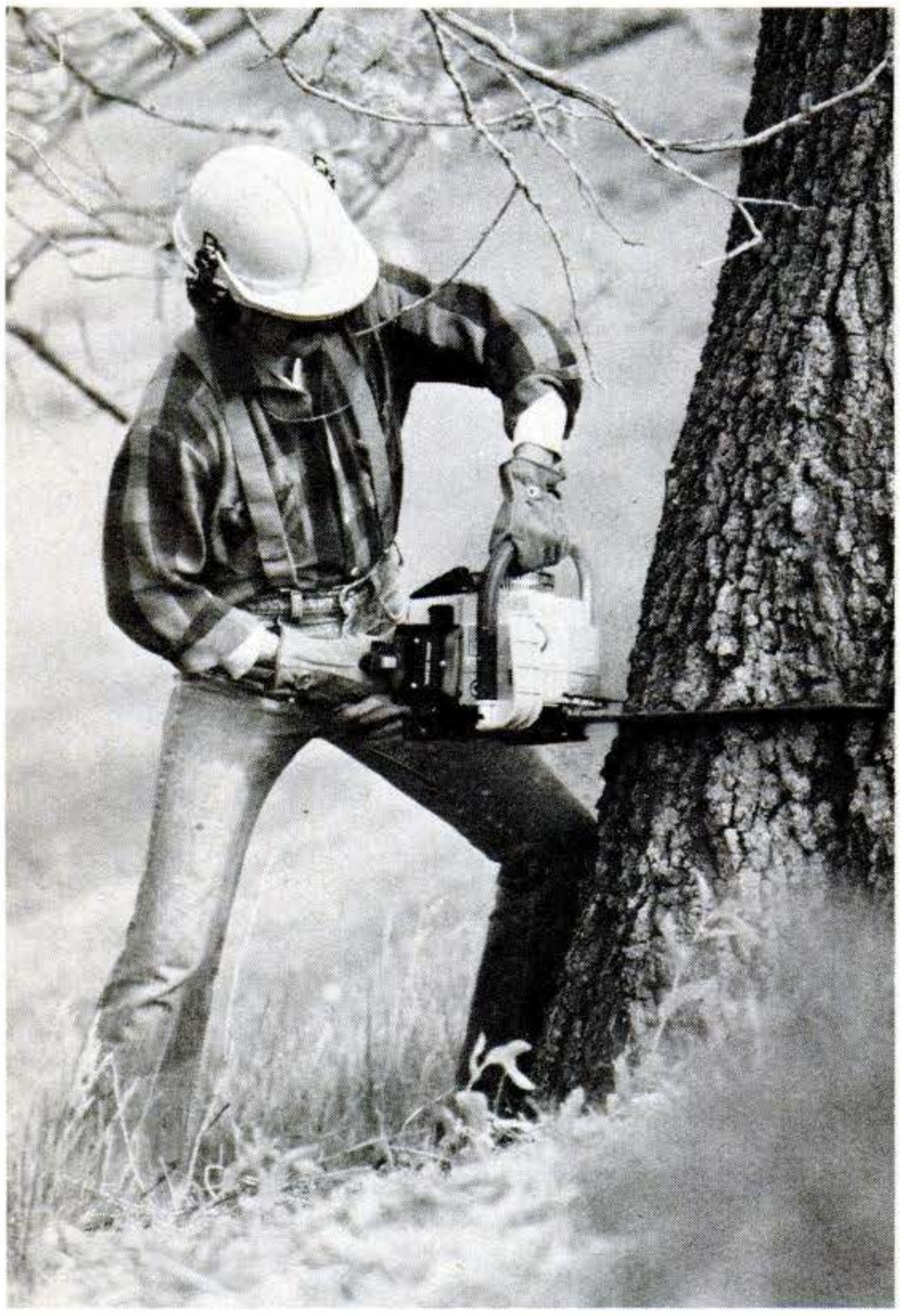
Lights: 12 mg "tar," 0.8 mg nicotine—
Kings & 100's: 17 mg "tar," 1.1 mg nicotine av.
per cigarette, FTC Report Dec.'79.

Come to Marlboro Country.

Marlboro Lights, Longhorn 100's and famous Marlboro Red—you get a lot to like.

Chain saws

New class of spunky lightweights for part-time woodcutters



Clever bar and chain design make '81 models the safest ever

By A.J. HAND

When you shop for a chain saw this autumn, you're in for some surprises. Manufacturers have introduced a whole new class of saws: lightweight models that will do serious woodcutting. Although these new chain saws have slightly smaller engines than mid-range machines, their light weight makes them easier to handle and less fatiguing to use. And many of them have extra-long bars with the capacity to tackle anybody's supply of winter wood.

The new saws are safer, too. The '81 models—many featuring the Guard Tip anti-kickback bar and 91SG cutting chain (see photo) just developed by Oregon—are said to be the safest ever. They have to be. The Consumer Product Safety Commission announced in June that it will soon be setting guidelines for chain saws. Although testing on the Guard Tip and 91SG has shown great improvement over older designs, no one is certain yet whether they will be the final breakthrough in safety. And there remains controversy about what safety concepts will prove to be the best.

Manufacturers are trying to produce chain saws that

Continued

John Deere 80 EV (left) is company's new top-of-the-line saw. Standard features include chain catch, hand guard, and throttle interlock. Oregon's asymmetric Guard Tip bar (below, left) is original equipment on nine brands in '81. With 91SG chain it reduces kickback forces by two-thirds. Stihl 010 AV (below) is quietest saw made, producing only 97 dBA, maker claims.

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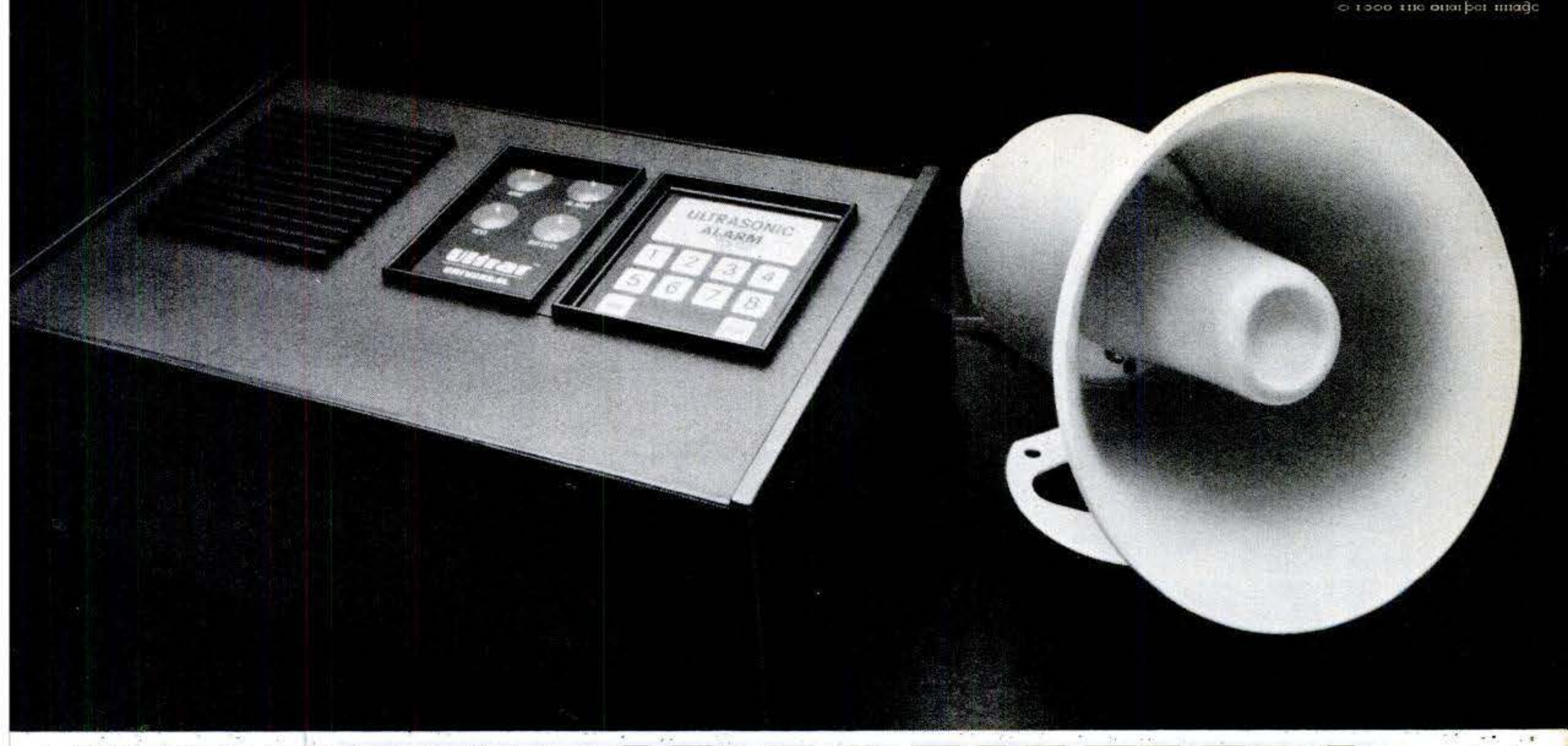


BUILD YOURSELF A FORTRESS. FOR THE PRICE OF A PEASHOOTER.

Today you can spend hundreds—even ousands of dollars—on a burglar alarm stem. Or try to get by for a lot less, and ind up with one that doesn't do the job.

Well, now from Universal Security struments, Inc. comes Ultrar™, an econom- al alarm system that gives you many of the phisticated features you normally find only th high cost protection. And it's available you by mail from The Sharper Image.

ocurity. Only 5 minutes away.

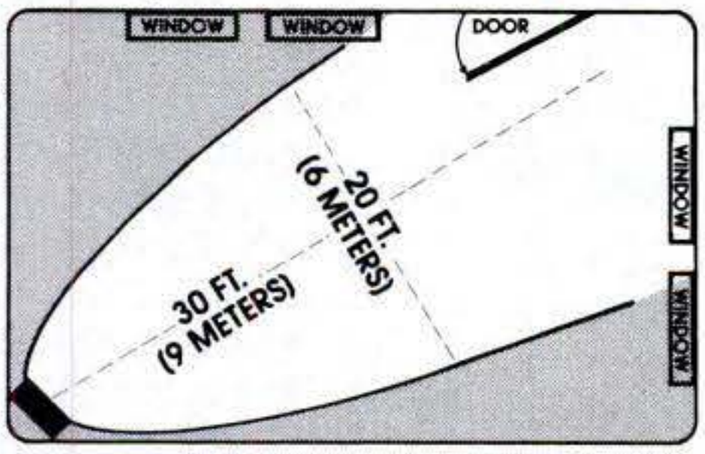
Packed with professional features, this mpact 10″×7″×3″ system requires no pensive installation, wiring, or monthly ntal charges. That's because it's fully port- le. And all yours.

Ultrar uses a technology that even the artest burglar can't fault—invisible ultra- nic (sound) waves that blanket a room as rge as 600 sq. ft. with protection; and thout falsing.

Remarkably, just a ger moving two inches ll set it off; needless to y, the movement of an ening window or door ll immediately activate e alarm (Ultrar is so nsitive, you'll need to move pets from the om).

And you can set up e entire system in less an 5 minutes. Just by ugging it into a wall outlet and making a w simple adjustments.

If power should ever fail, or the unit be plugged, Ultrar's built-in battery back-up ready to take over (six C-cell batteries will ovide months of service, if needed).



Ultrar protects any room (up to 600 sq. ft.) with an adjustable cone-shaped ultrasonic shield. May be placed near a hallway, guarding access to all doorways.

There's no guessing that it's working.

Ultrar is unique in being the only economical burglar alarm system that gives you a precise picture of the extent of its protection.

In its special Test Mode, you can actually walk through a room, open doors, try windows, etc., and watch your unit being triggered by these routine movements. During these tests, you get a clicking tone (with indicator light) that's less than one twentieth the volume of the regular alarm siren that's ready to greet any unwelcome guest.

This exclusive test feature insures proper placement of the unit, and the ideal adjustment of its sensitivity control.

Now for the real thing.

Ultrar is armed with the press of a single button.

This same button activates a 60 second exit delay, giving you ample time to leave. And providing you with peace of mind—whether it's for an hour, or a two-month vacation.

If an intrusion does occur, Ultrar is programmed to do one of two things: (1) Surprise the intruder (and alert the neighbors) with a siren that can't be stopped—even by unplugging the unit. (Once activated, the siren alarm continues for three minutes before automatically resetting itself in preparation for the next movement.) Or (2), it can be immediately disarmed, but only when you enter your secret 3-number code on its pressure sensitive pad.

The unit is also designed to wait 30 seconds after entry, giving you ample disarming time. And lets you know instantly, with the aid of a memory-assisted alarm light, whether or not the alarm was triggered while you were out.

The deciding factor.

The Sharper Image has been waiting two years to offer a reasonably priced protection system. And when we heard Ultrar's built-in 90+ decibel siren, we knew we had found what we were looking for.

We were further convinced by its external indoor/outdoor weatherproof speaker (50′ cord and jack included), which enables you to extend this already piercing alert signal to the entire neighborhood—or make your inside warning sound twice as penetrating (system is available without additional speaker for $20 less).

And we'll give you two full weeks to make up your mind. If for any reason you don't share our enthusiasm over Ultrar, please return it for a prompt, courteous refund. Includes 90 day warranty, warning decals, and full instructions.

ORDER NOW TOLL FREE.

For dual siren system, order product #246 for $109. For Ultrar without the additional indoor/outdoor speaker, order #245 for $89. Add $3.50 delivery, and $6.54 or $5.34 sales tax, respectively, in California. Credit card holders may call the toll free number below, or send check. Please mention this magazine.

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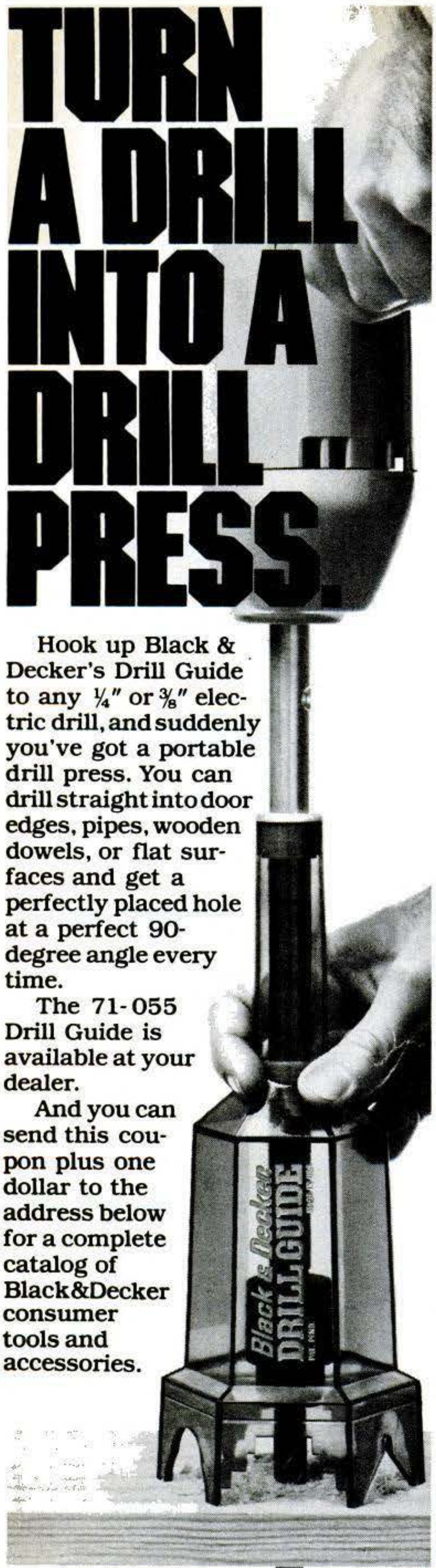
TURN A DRILL INTO A DRILL PRESS.



Hook up Black & Decker's Drill Guide to any ¼" or ⅜" electric drill, and suddenly you've got a portable drill press. You can drill straight into door edges, pipes, wooden dowels, or flat surfaces and get a perfectly placed hole at a perfect 90-degree angle every time.

The 71-055 Drill Guide is available at your dealer.

And you can send this coupon plus one dollar to the address below for a complete catalog of Black&Decker consumer tools and accessories.

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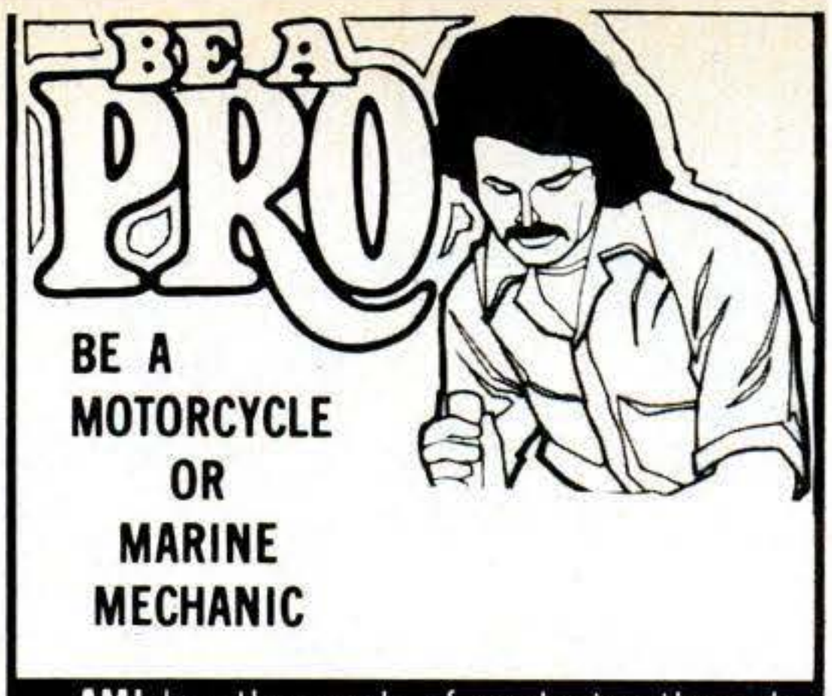

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Chain saws

[Continued]

part-time woodcutters, especially first-time buyers, won't back off from because of size, capacity, or safety. I think they've probably succeeded.

To review the new models and safety developments, I tested the saws, talked with engineers and the Consumer Product Safety Commission, and traveled to Homelite's North Carolina testing center. Here's what I found out.

Bar-chain combination

This year's biggest engineering (and safety) news is Oregon's Guard Tip bar and 91SG cutting chain. Oregon says the new bar and chain can significantly reduce both the frequency and force of chain-saw kickback, the largest cause of chain-saw injuries. They are being offered as original equipment on no fewer than nine different makes of saws.

To understand the new bar and chain, you have to know a bit about kickback. When teeth cut hard or snag on wood at the upper part of the bar's end, the saw will kick up and back toward the operator (see the box on kickbacks, next page). Oregon developed an asymmetric bar and snag-free chain to overcome this problem. The design seems to have succeeded quite well. In Oregon's own testing, combining the 91SG chain with a Guard Tip bar reduced kickback torque by two-thirds compared with performance of a 91S on a symmetrical bar—from 17 inch-pounds to five.

Although the Consumer Product Safety Commission (CPSC) isn't saying so officially, it is well known in the industry that the 91SG chain has been tested by CPSC and performed well. CPSC compared the kickback forces of the new chain (without the Guard Tip bar) with other original equipment chains. The results show reductions in kickback forces for the 91SG ranging from 59 to 74 percent.

What do these numbers mean in terms of actual improvements in safety? The CPSC doesn't really know yet. Oregon's Curt Graversen says it means that the 91SG reduces kickback energy "to a point where the kickback is very easily managed by the saw operator." But at the same time he cautions: "Even if you had a chain with no cutters, it would still have a tendency to kick upward."

Reducing kickback is one thing. Doing it without hurting cutting performance is another. As Homelite's safety expert Vince Morabit points out, a saw that cuts poorly can present safety problems of its own. Users might

Continued

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a $5 LCD digital WATCH

NOW WITH STOP WATCH

Try only 10 DAK high energy 90 minute cassettes risk free for just $2.19 each and get a beautiful $69 value LCD digital watch for only $5!

YOU CAN'T LOSE!!! IF YOU'RE NOT 100% SATISFIED, KEEP AN ML90 FREE AS A GIFT FOR TRYING OUR CASSETTES!!!

Are the very high frequencies disappearing from your cassettes as you play them? Friction within your cassettes may be erasing your crystal clear highs even as you read this ad.

DAK developed a jam proof cassette for professional high speed duplicators and in the process discovered why recordings that sound great when you make them, may sound less than great in just a few months.

Here's a chance to try DAK ML90s risk free and pick up a great LCD watch complete with stop watch for only $5!

YOUR TIME IS PRECIOUS

Imagine yourself just finishing recording the second side of a 90 minute cassette and horrors, the cassette jams. Tape is wound around the capstan, your recorder may be damaged and you've just wasted 90 minutes of your time and perhaps lost a great recording off FM.

MOLYSULFIDE

DAK manufactures enough tape for over one million cassettes per month, mostly for professional duplicators and loaders. We developed polyester slip sheets which are inside the cassette with raised spring loaded ridges to guide each layer of tape as it winds so it won't jam.

We coat the liners with a unique formulation of graphite and a new chemical called molysulfide. It reduces friction several times better than graphite and allows the tape to move more freely within the the cassette.

HIGH FREQUENCY PROTECTION

Tape is basically plastic, and as it moves within the cassette friction causes the build up of static electricity, much as scuffing your shoes on a carpet in dry weather.

Static electricity within the cassette is drastically reduced by the low friction of the molysulfide so that it won't erase crystal clear highs. A very important consideration for often played tapes.

MAXELL 'TAPE' IS BETTER

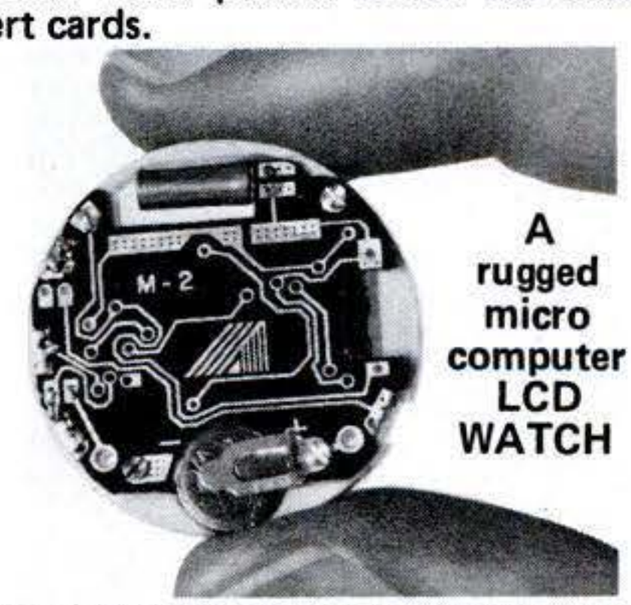
Yes, honestly, if you own a $1000 cassette deck like a Nakamichi, the frequency responses of Maxell UDXL or TDK SA are superior and you just might be able to hear a difference.

DAK ML has a frequency response that is flat from 40hz to 14,500hz ±3db. Virtually all cassette recorders priced under $600 are flat ±3db only from 40hz to about 12,500hz, so we have over 2000hz to spare, and you'll probably never notice the difference, and we feel that we have equaled or exceeded the mechanical reliability of virtually all cassettes.

NOT MAGICAL OR CHEAP

DAK manufactures the tape we sell. Our tape really doesn't cost less to make. You only avoid paying the wholesaler and retailer costs and profits. When a cassette leaves other factories, it must be marked up each step of the way; even duty on some of the fine imported cassettes must be added, so with DAK tape you really only save the middlemen profits.

While Maxell UDXL 90s may sell for $3.50 to $4.50 each at retail, DAK ML90s sell factory direct to you for only $2.19 each complete with deluxe all clear hard plastic boxes and index insert cards.



A rugged micro computer LCD WATCH

A $5 LCD WATCH++STOP WATCH?

This beautifully styled slim silvertone watch is loaded with features. LCD means that the time in hours and minutes always shows without having to push buttons.

Push the button once, and you'll see the date in months and days, and push the button again and see seconds. Push the second button and the entire time section lights up for convenient night viewing.

Stop watch feature. This fine watch has a third button which starts and stops an accurate stop watch. The stop watch displays up to 15 minutes and then continues running displaying up to 15 minutes at a time. It's great for timing cassettes.

Quartz crystal accuracy means constant time within 1 minute per month. Crystals use little electricity, so the battery should last up to a year, and is easily changed.

Stainless steel band for long life and comfort. No imitation, a first rate locking adjustable band.

It's guaranteed. This fine watch comes with a manufacturer's limited warranty, good for one full year.

DAK TAKES A RISK

Obviously giving away quality watches is not going to make DAK rich. We are betting that once you get our new 40 page catalog with over 6000 words about how to make better recordings, you will want to buy our cassettes again, and we are putting our money where our mouth is!

Customers like you are very valuable in the form of future business. We anticipate receiving over 6000 orders and over 4500 repeat customers from this advertisement to add to our list of over 80,000.

TRY DAK ML90 CASSETTES RISK FREE

Try these high energy cassettes on your own recorder without obligation for 30 days. If you aren't 100% satisfied for any reason, return only 9 of them and the watch for a refund. The cassette you test recorded is yours as a gift.

To order your 10 DAK ML 90 minute high energy cassettes at $2.19 each and get the LCD digital watch for only $5 with your credit card, simply call the toll free number below, or send your check for **only $21.90** plus **$5** for the watch and **$3** for postage and handling for each group to DAK. (CA residents add 6% sales tax).

DAK unconditionally guarantees all DAK cassettes for one year against any defects in material or workmanship.

Why not order an extra group of 10 DAK ML90 cassettes for yourself or a friend? We will add one free ML90 cassette to each additional group you buy and of course you can still get an LCD watch for only $5 with each additional group you order.

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try to force the saw, or tire and become careless. Kickback injuries might be reduced, but other types could become more common.

But Oregon's Graversen says the new bar does not hurt cutting performance at all, and in fact may improve it slightly when boring. "On the flat portion of the bar," he says, "the difference in cutting speed would be negligible. Cutting with the nose buried suffers a little, but you would need a stopwatch to detect the difference between a 91S and a 91SG."

Oregon is tooling up to produce the new bar and chain as rapidly as possible, but they may be in short supply for a while. Both will be available as original equipment on some saws—sometimes together, sometimes just the bar. Both will also be sold as replacement parts, letting you convert your existing saw. The bar will be made in a pro model with a replaceable sprocket nose and a consumer model with a permanent sprocket nose. The bar will be sold in pitches of ⅜ and .325 inches, while the chain will be made in ⅜-in. pitch only.

New models

Homelite has two new models this fall: the 190 (31 cc), a lightweight, and the 330, a new mid-range saw with a 54-cc engine. The 190 will be the first of the company's saws to have a new automatic sharpening system. Like other self-sharpening systems, the 190 will have a top sharpening system, honing the top of the tooth.

Past automatic sharpening systems have had three major problems:

- Though top sharpening works, critics have claimed it never really brings the chain back to factory-sharp condition. After a bit of use, the chain drops to about 60 percent of original sharpness.
- After a number of sharpenings, hand filing is required to reshape the gullet of the tooth.
- The honing stone on sharpening systems tends to groove unless handled expertly. Grooving will eventually deform the teeth.

Homelite engineers claim they have solved these problems. By reshaping the teeth, they have eliminated the gullet and the need to periodically file by hand, while creating a shape that can be honed to about 90 percent of factory sharpness. To eliminate grooving, the cylindrical stone rotates as it hones so it wears evenly.

One drawback to top sharpening is that it requires an aggressive tooth design, which tends to increase kickback. As a result, Homelite has decided to permanently attach its anti-kickback nose guard on the 190. This eliminates the problem of kickback, but also makes cutting with the nose buried impossible. The saw compensates somewhat for this shortcoming with a 16-in. bar, which is somewhat longer than the standard bar on saws in this size range.

Homelite engineers have spent four years on the 330 model to develop a powerful but lightweight design. They have cut weight by extensive use of high-quality plastics. These are not ordinary materials, but special plastics reinforced with glass fibers and custom-formulated resins. John Shelton, Homelite's director of engineering, says that these plastics are used "only when they serve as well as, or better than, the metal parts they replace. The plastics not only reduce weight, but also cut costs by eliminating machining steps such as drilling and tapping for machine screws." The 330 will take bars 16 to 23 inches long. Homelite is working on its own anti-

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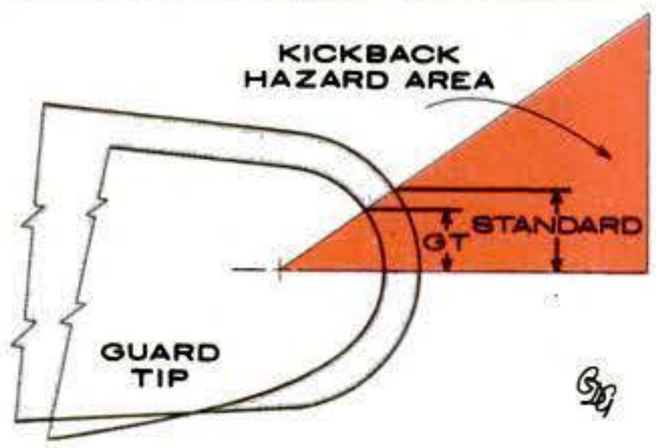
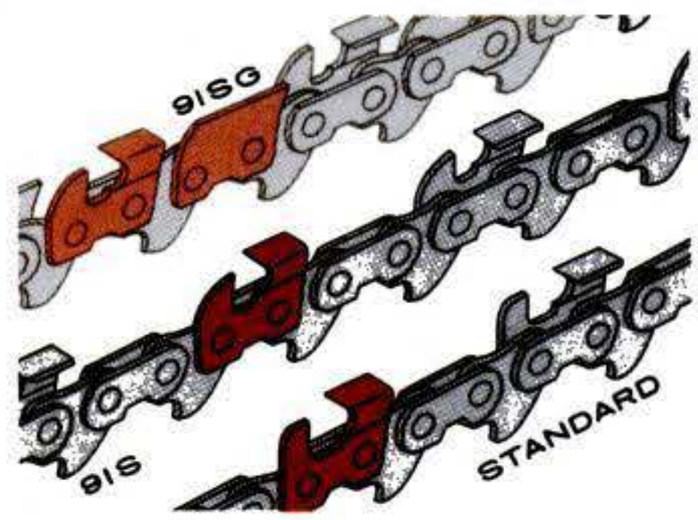
Kickback—and its remedies





Kickback occurs when the chain's teeth or depth gauges snag wood in the upper quadrant of the bar nose (shaded area in the drawing above, left). Decreasing the radius of the bar's nose reduces the frequency and force of kickback. However, decreasing the radius increases wear at the bar tip, affecting performance. Oregon Chain Saw's Guard Tip may be the answer. It retains the small radius, but moves it up, off center, permitting a gradual curve at bottom for better cutting.

Oregon also found two flaws in the design of the standard chain that aggravated kickback: the shapes of the depth gauges, which caused them to grab, and the short length of the cutters, which let them roll back, digging deeper into the wood. Oregon's 91S chain alleviates these problems (see drawing above for comparison of standard, 91S, and 91SG chains). The 91SG is a refinement of the low-profile 91S, with a special guard link in front of the cutter to make cutting smoother.

Homelite's Safe-T-Tip nose guard (top photo) bolts onto the bar nose and covers the kickback quadrant, preventing kickback and cutting by the bar tip.

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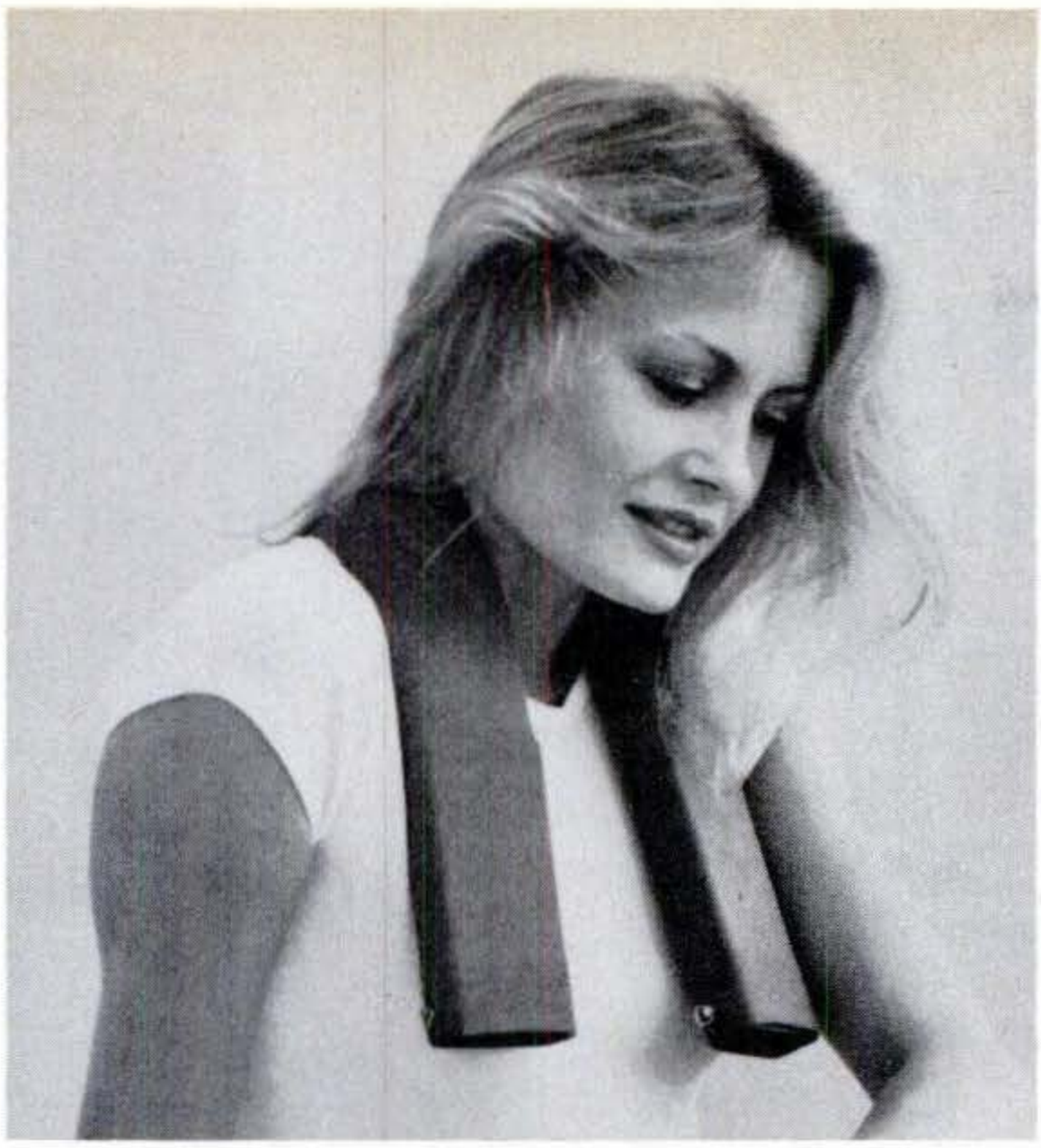

Bone Fone T.M.

A new concept in sound technology may revolutionize the way we listen to stereo music.

The Bone Fone surrounds your entire body with a sound almost impossible to imagine.

You're standing in an open field. Suddenly there's music from all directions. Your bones resonate as if you're listening to beautiful stereo music in front of a powerful home stereo system.

But there's no radio in sight and nobody else hears what you do. It's an unbelievable experience that will send chills through your body when you first hear it.

AROUND YOU

And nobody will know you're listening to a stereo. The entire sound system is actually draped around you like a scarf and can be hidden under a jacket or worn over clothes.

The Bone Fone is actually an AM/FM stereo multiplex radio with its speakers located near your ears. When you tune in a stereo station, you get the same stereo separation you'd expect from earphones but without the bulk and inconvenience. And you also get something you won't expect.

INNER EAR BONES

The sound will also resonate through your bones—all the way to the sensitive bones of your inner ear. It's like feeling the vibrations of a powerful stereo system or sitting in the first row listening to a symphony orchestra—it's breathtaking.

Now you can listen to beautiful stereo music everywhere—not just in your living room. Imagine walking your dog to beautiful stereo music or roller skating to a strong disco beat.

You can ride a bicycle or motorcycle, jog and even do headstands—the Bone Fone stays on no matter what the activity. The Bone Fone stereo brings beautiful music and convenience to every indoor and outdoor activity without disturbing those around you and without anything covering your ear.

SKI INVENTION

The Bone Fone was invented by an engineer who liked to ski. Every time he took a long lift ride, he noticed other skiers carrying transistor radios and cassette players and wondered if there was a better way to keep your hands free and listen to stereo music.

So he invented the Bone Fone stereo. When he put it around his neck, he couldn't believe his ears. He was not only hearing the music and stereo separation, but the sound was resonating through his bones giving him the sensation of standing in front of a powerful stereo system.

AWARDED PATENT

The inventor took his invention to a friend who also tried it on. His friend couldn't believe what he heard and at first thought someone was playing a trick on him.

The inventor was awarded a patent for his idea and brought it to JS&A. We took the idea and our engineers produced a very sensitive yet powerful AM/FM multiplex radio called the Bone Fone.

The entire battery-powered system is self-contained and uses four integrated circuits and two ceramic filters for high station selectivity. The Bone Fone weighs only 15 ounces, so when worn over your shoulders, the weight is not even a factor.

BUILT TO TAKE IT

The Bone Fone was built to take abuse. The large 70 millimeter speakers are protected in flexible water and crush resistant cases. The case that houses the radio itself is made of rugged ABS plastic with a special reinforcement system. We knew that the Bone Fone stereo may take a great deal of abuse so we designed it with the quality needed to withstand the worst treatment.

The Bone Fone stereo is covered with a sleeve made of Lycra Spandex—the same material used to make expensive swim suits, so it's easily washable. You simply remove the sleeve, dip it in soapy water, rinse and let the sleeve dry. It's just that easy. The entire system is also protected against damage from moisture and sweat making it ideal for jogging or bicycling.

The sleeve comes in brilliant Bone Fone blue—a color designed especially for the system. An optional set of four sleeves in orange, red, green and black is also available for $10. You can design your own sleeve using the pattern supplied free with the optional kit.

YOUR OWN SPACE

Several people could be in a car, each tuned to his own program or bring the Bone Fone to a ball game for the play by play. Cyclists, joggers, roller skaters, sports fans, golfers, housewives, executives—everybody can find a use for the Bone Fone. It's the perfect gift.

Why not order one on our free trial program and let your entire family try it out? Use it outdoors, while you drive, at ball games or while you golf, jog or walk the dog. But most important—compare the Bone Fone with your expensive home stereo system. Only then will you fully appreciate the major breakthrough this product represents.

GET ONE SOON

To order your Bone Fone, simply send your check or money order for **$69.95** plus $2.50 postage and handling to the address shown below. (Illinois residents add 5% sales tax.) Credit card buyers may call our toll-free number below. Add $10 if you wish to also receive the accessory pack of four additional sleeves.

We'll send you the entire Bone Fone stereo complete with four AA cell batteries, instructions, and 90-day limited warranty including our prompt service-by-mail address.

When you receive your unit, use it for two weeks. Take it with you to work, or wear it in your car. Take walks with it, ride your bicycle or roller skate with it. Let your friends try it out. If after our two-week free trial, you do not feel that the Bone Fone is the incredible stereo experience we've described, return it for a prompt and courteous refund, including your $2.50 postage and handling. You can't lose and you'll be the first to discover the greatest new space-age audio product of the year.

Discover the freedom, enjoyment, and quality of the first major breakthrough in portable entertainment since the transistor radio. Order a Bone Fone stereo at no obligation, today.

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The Classic Car Museum presents

The world's great classic cars silver miniatures

The complete collection of officially recognized international classics — each portrayed in brilliant micro-detail

You can acquire these superb sterling silver miniatures — at just $9.50 each — by entering your subscription now.

At first glance, your eye is attracted by the captivating glow of silver. Fascinated, you look closer . . . and the lines of an automobile begin to take shape. Then, you place the silver miniature under a magnifying glass — and there, in remarkably clear and precise detail, is one of the world's great classic cars!

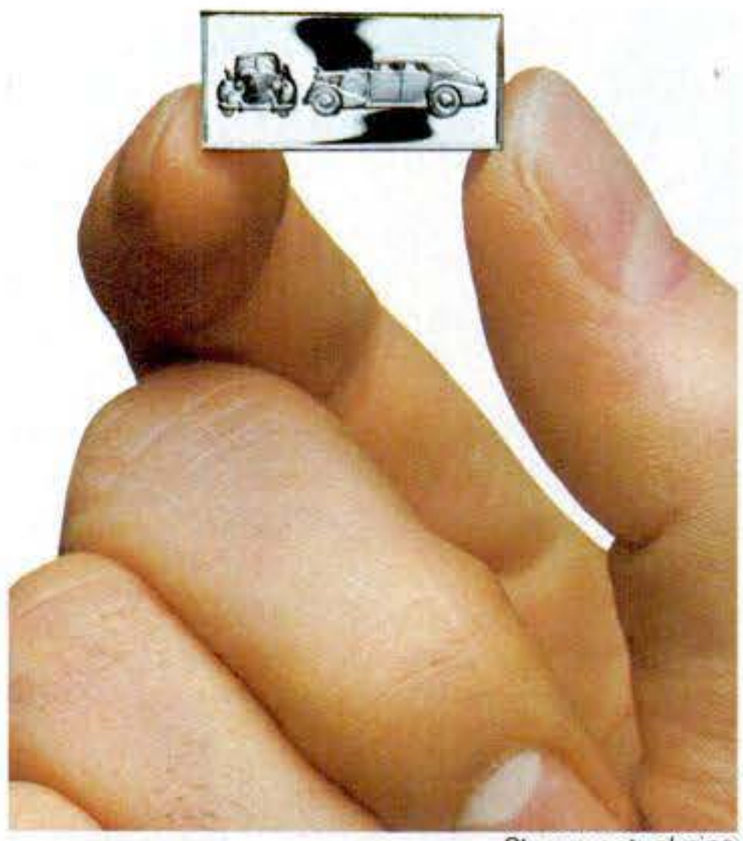
This is the excitement that awaits you in every issue of *The Official Classic Cars Silver Miniature Collection,* as you discover the intriguing world of the minted miniature. A world that combines the beauty of solid sterling silver with the fascination of meticulous detail in the tiniest area . . . and the precision of a perfectly formed yet minute work of craftsmanship.

Issued by The Classic Car Museum and produced by The Franklin Mint, this extraordinary new collection will consist of 63 such carefully crafted miniatures. Each will portray — with *complete accuracy and authenticity* — one of the world's greatest, most beautiful and most distinctive luxury automobiles. And, to assure its rarity, the collection is being made available *solely* by direct subscription, and *only* for a limited period of time.

The finest and most luxurious cars ever built

The classic car has been officially defined by The Classic Car Club of America as a "fine and distinctive American or foreign car built between 1925 and 1948." Yet out of the thousands of cars that have been produced over the years, *only 63 marques* qualify as true classics. And *each* of these marques will be represented in this collection by one notably distinguished model. Among them will be:

The 1928 Isotta Fraschini Landaulet Cabriolet, Italy's most coveted luxury car – and a favorite of wealthy European families.



Shown actual size.

The 1927 Bugatti Royale, often called the "thoroughbred" of the motoring world. A perfect combination of craftsmanship, outstanding design and mechanical excellence.

The 1929 SSK Mercedes Benz. A real eye-stopper because of its elegant styling – and distinguished for its performance.

The 1939 V-12 Packard. Originally owned by the famous actor Errol Flynn, it features a leather top, horse-hide upholstery, fur flooring, hydraulic brakes and concealed aerial.

And such equally famous marques as the Lincoln, Bentley, Auburn, La Salle, Marmon, Peerless, Stutz, Chrysler, Renault, Talbot, Mercer – *every one of the 63 officially recognized international classics.*

Flawlessly crafted works in miniature

Each superb sterling silver miniature will recapture, with astonishing accuracy and exacting detail, the special features that set one historic car apart from all others. You will actually be able to see and identify every one of the spokes on the wheels of the 1934 Duesenberg. The ornate hood ornament on the 1926 Rolls-Royce Phantom I. The windshield wipers on the 1938 Lincoln Coupe. Even the different car *emblems* can be clearly seen!

So that the design of each car can be fully appreciated, moreover, the silver miniatures will be minted in an unusual *oblong shape.* This will allow every car to be displayed in *two* different ways: from the front *and* from the side.

To assure complete accuracy, The Franklin Mint obtained permission from the owners of the cars represented to examine these great cars at first hand. Thus, each silver miniature is a *totally authentic* portrayal of one of the great classic cars.

Special magnifier included

To enable subscribers to study each silver miniature in close-up detail, *a special magnifying glass* will be sent at no additional charge with the first shipment. This precision magnifier is mounted on a stand for easy and effective use. And it's fully collapsible as well, so it can be safely stored in its own protective cover when not in use.

Furthermore, each subscriber will receive a handsome collector's case, custom-designed to house and protect all the silver miniatures. This finely crafted case provides a convenient and attractive means for displaying the collection – and enjoying each individual miniature.

A miniature treasure in silver . . . at a guaranteed price

You will be able to build the complete collection of silver miniatures conveniently – and at surprisingly low cost. Each month, beginning in January, you will receive one new miniature for your collection. The price for each sterling silver miniature is just $9.50. And this favorable price will be *guaranteed* to you for the entire subscription period – a most significant guarantee in these days of constantly fluctuating prices.

By authority of The Classic Car Museum, *The Official Classic Cars Silver Miniatures* will be issued in limited edition and by direct subscription only. The number of complete sets to be issued will be permanently limited to the exact number of subscriptions entered by the end of 1980.

Subscription deadline: December 31, 1980

Whether you are an admirer of beauty in silver . . . a person who is intrigued by intricately detailed works of art in miniature . . . or a devoted car buff, this collection

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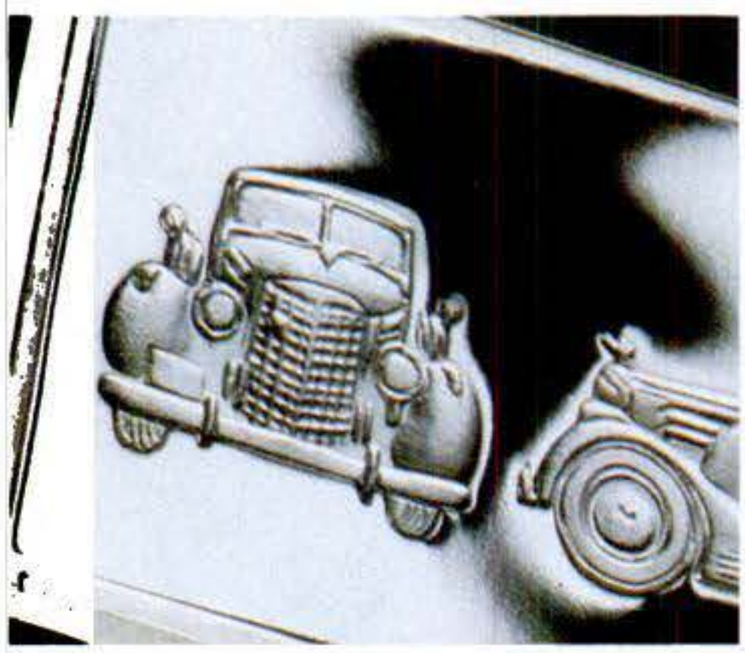
will provide great pleasure and satisfaction for you and your entire family, throughout the years to come.

To acquire *The Official Classic Cars Silver Miniature Collection*, you must mail the application at right by December 31, 1980. No payment is required at this time – but be sure to act by December 31st at the very latest.



1938 Cadillac Convertible silver miniature illustrated above is approximately five times actual size to show fine detail.

© 1980 FM

SUBSCRIPTION APPLICATION

The Official Classic Cars Silver Miniature Collection

The Classic Car Museum
c/o The Franklin Mint
Franklin Center, Pennsylvania 19091

Must be postmarked by December 31, 1980.
Limit: One collection per person.

Please enter my subscription for *The Official Classic Cars Silver Miniature Collection* consisting of 63 finely detailed sterling silver miniatures, to be issued to me at the rate of one per month, at the guaranteed issue price of $9.50* per miniature. I will be billed for each of my silver miniatures prior to shipment. A special magnifier will be included with my first shipment, and I will also receive a custom-designed collector's case.

**Plus my state sales tax and 50¢ per shipment for postage and handling.*

Signature _____
ALL APPLICATIONS ARE SUBJECT TO ACCEPTANCE

Mr.
Mrs.
Ms. _____
PLEASE PRINT CLEARLY

Address _____

City _____

State, Zip _____

Canadian residents will be billed for each miniature in advance of shipment at $12.50 plus 75¢ for shipping and handling ($CND).

The Franklin Mint is the world's largest private mint. It is not affiliated with the U.S. Mint or any other government agency.

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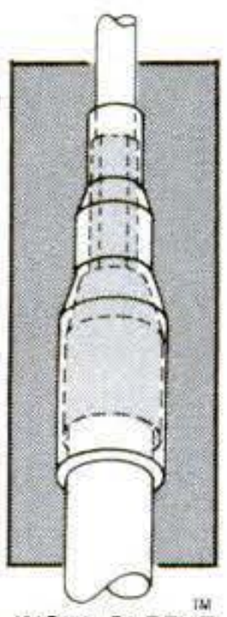
CB Cowboy's BEST BOOT

SHAKESPEARE'S SUPER BIG STICK®

fully insulated fiberglass CB base station antenna

At home on the wide open range or atop a roof in the crowded city. Performance has made the 18' Super Big Stick the most popular base station antenna on the market. Skillful engineering combined with its fully insulated fiberglass two piece construction make Super Big Stick one of a kind. Pop the black Insul-Sleeve™ boot in place and you're set to go!



INSUL-SLEEVE™ Molded black ethylene propylene/rubber sleeve protects metal connector against accidental electrical contact.

- Withstands 13,000 volts accidental electrical contact... protection no other base antenna can match!
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kickback bar, but until it's ready the company is relying on its nose guard for kickback safety.

Small saws

A trio of new saws—the Stihl 010 AV, the Jonsereds 510 SP, and the Echo CS-280—are among the smallest, lightest saws ever produced by their respective manufacturers. Still, none of these saws is a toy. I used the Stihl with a 16-in. bar, and though the saw feels like a lightweight, it cuts like a middleweight. Its anti-vibration system makes the saw a comfortable one to use. And at 97 dBA, it's also the quietest saw on the market. The 010 has a 37-cc engine and weighs just 9.9 pounds with a small bar. The saw I tried has a hand guard, but Stihl's Quickstop chain brake is available as an option.

Jonsereds calls the 510 SP the first of a new generation of saws. It can take bars up to 18 inches long and is simply constructed, having less than 200 parts (many saws this size have 300–400). Its compact size and 10½-pound weight put the 510 SP in a class with the minis. But its 49-cc engine and guide bars of up to 18 inches rank with the mid-size saws.

The 510 SP has a semi-automatic choke. You switch it on before starting, and then it clicks off automatically when the motor catches. So there's no fumbling with the choke to keep the engine from stalling. A hand guard is standard, but there's an optional chain brake, too.

The CS-280E is the smallest saw ever made by Echo. With a 28-cc engine it qualifies as one of the minis. It weighs just 7½ pounds with its bar and chain. The only bar size available with this new model is 12 inches.

Mid-size saws

Echo's newest in the mid- to upper-size category is the 65-cc CS-650 EVL. This is a powerful saw that will take bars up to 27 inches long. It features an electronic ignition and an anti-vibration system. Like all other Echo saws, it has the new Guard Tip bar.

Other new saws in the mid-size range are John Deere's 55V and Poulan's 3400 Counter Vibe. The Deere 55V has an anti-vibration package that includes rubber engine mounts and extra rubber padding on the front handgrips for added comfort. The fuel tank is separate from the cylinder to prevent vapor lock when running hot. As with other V-series saws, the 55 features nonmodular construction to allow easy replacement of powerhead components. The 50-cc engine powers bars up to 24 inches long. Safety features include chain catch, throttle interlock, guard-link chain, and hand-guard or optional chain brake. Deere also has a new big saw this year, if you want to go all the way. The 80V can take bars up to 27 inches long, and it has a 79-cc engine with solid-state ignition.

Lloyd Tuggle, head of Poulan engineering, says the Poulan 3400 is the result of more than three years of development. Its anti-vibe system absorbs up to 78 percent of the saw's vibration. The 3400 is another saw that will be equipped with the Oregon guide bar. (Poulan calls its version the Control Tip.) The 3400 has a 56-cc engine, solid-state ignition, and needle bearings throughout. PS

Timed test cuts with self-sharpening saw are made by Homelite engineers. With new tooth design, 190 will never need hand sharpening, Homelite claims.

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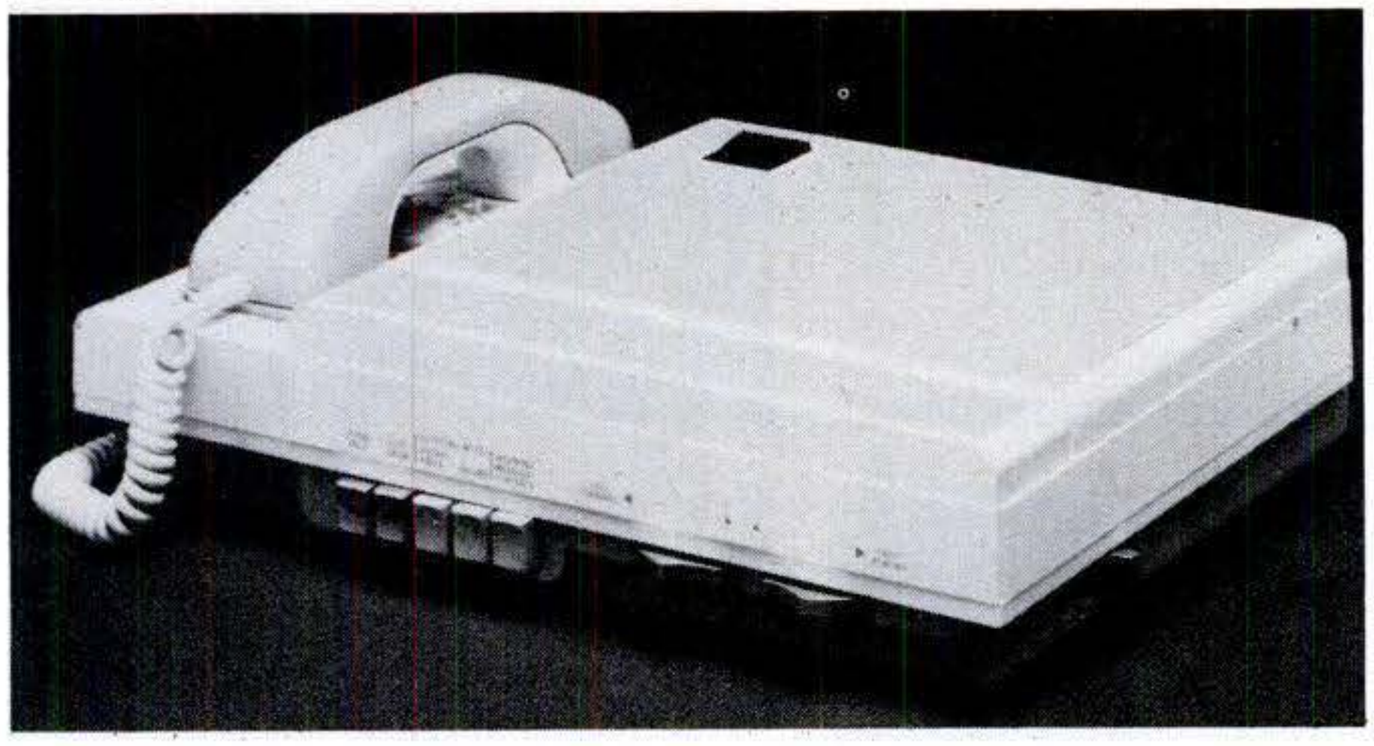
The ITT unit requires no pager to retrieve your messages and records only true messages.



A new telephone answering computer from ITT recognizes your voice signal and plays back your messages without a pager. But there's plenty more.

Voice Recognition

It's not cheap. The new ITT telephone answering computer is $400. But for that price you get, without question, the most convenient and advanced system in the world.

NO PAGER

Most remote telephone answering units require a paging device to retrieve messages. The ITT unit does not. You simply phone your unit, and in your own voice, repeat a voice code. It will automatically recognize it, rewind to your first message and play all your messages back. You don't need a pager.

You can select from 25 different voice codes and change them anytime right at your unit. Not only do you have the extra security of a unique code, but the flexibility of changing it anytime you want. But there's more.

PURE MESSAGES

If you own a remote system now, you know what happens when you call in and find that most of your callers hung up and left no message. Or if they left a message and hung up, there's a lot of empty space and a dial tone at the end of the incoming message. Not so on the ITT unit.

The ITT system recognizes hang-ups and dial tones and rewinds itself automatically before the next message is received. You end up with pure messages so the time you save listening to unnecessary sounds is significant. But there's even more.

VARIABLE LENGTH

Most units have a time limit for an incoming message—usually 30 seconds. The ITT unit has a variable message length up to 3 minutes. The unit's computer will sense the caller's voice and record only the exact length of the message. Again, there's no wasted time. You record only as much or as little as you need.

BUILT-IN PHONE

The unit comes with a built-in telephone that also acts as your outgoing announcement microphone. You can receive, make calls, and change your messages—all with the same unit.

The outgoing messages are recorded on a continuous loop cartridge. This means that you can record different messages on different cartridges and select the exact message you need. The cartridges cost only $5 each. All incoming messages are recorded on an inexpensive audio cassette that will last years and can be purchased locally for a few dollars.

MORE FEATURES

There are many more features that make ITT's unit the most deluxe answerer you can buy anywhere.

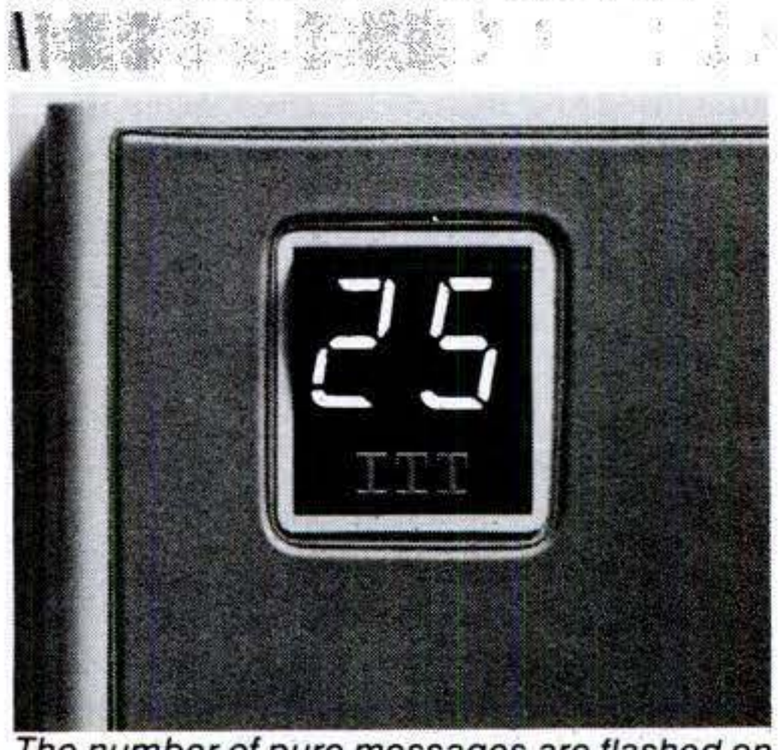
Last Message Signal After you listen to your last message, you hear three beeps—a signal that you've reached the end.

Save or Rewind After you listen to your last message, you can either hang up and save all of your messages or you can rewind to the beginning. The choice is yours. Even many of the expensive units don't have this feature.

Last Message Announce When you receive 25 messages (the capacity of the unit) instead of not answering at all, the unit will go into its "full" mode and the caller is told to call back later without taking a message.

Message Counter Not only can you see the number of calls you receive but the large LED readout also counts off seconds as you record to tell you the length of your outgoing announcement. The counter has other signals to tell you when to record and what message you're at during playback.

Handsome Appearance The system looks great on any desk and a telephone fits easily on its cover. It measures 3½" x 10" x 14".



The number of pure messages are flashed on the large LED display.

The ITT should be a service-free system. The recording tapes are often the first thing that goes wrong with other units. With the ITT telephone answering system, you simply plug in a new tape. Nevertheless, the unit is backed by national service centers and a service-by-mail facility. JS&A is America's largest single source of space-age products—further assurance that your modest investment is well protected.

We urge you to order a system for our 30-day telephone answering test. When you receive the unit, plug it in and see how fast you can record your messages. See how simple it is to operate. See how convenient it is not to have a pager when you retrieve your calls. But above all, see how fast you retrieve messages without having to listen to hang-ups and dial tones.

Then within 30 days decide if you want to keep it. If not, no problem. Simply return your unit and we'll send you a prompt and courteous refund including your $4.50 postage, handling and insurance. There is no risk.

To order your ITT answering system, simply send your check or money order for **$395** plus $4.50 for postage and handling (Illinois residents please add 5% sales tax) to JS&A Group, Inc., at the address below. Credit card buyers, please call our toll-free number below. Each unit comes complete with an AC plug-in power supply, modular connector, one-year limited warranty, complete instructions and both the outgoing and incoming tapes. If you require a four-prong adapter, please indicate this and one will be supplied free of charge with your unit. This unit is FCC approved so if you don't have a modular plug or four-prong adapter, simply call your phone company and they will be delighted to install one for you.

We know of no other telephone answering system that is better designed and more advanced than the ITT system. But then you pay for what you get. Order an ITT telephone answering computer at no obligation today.

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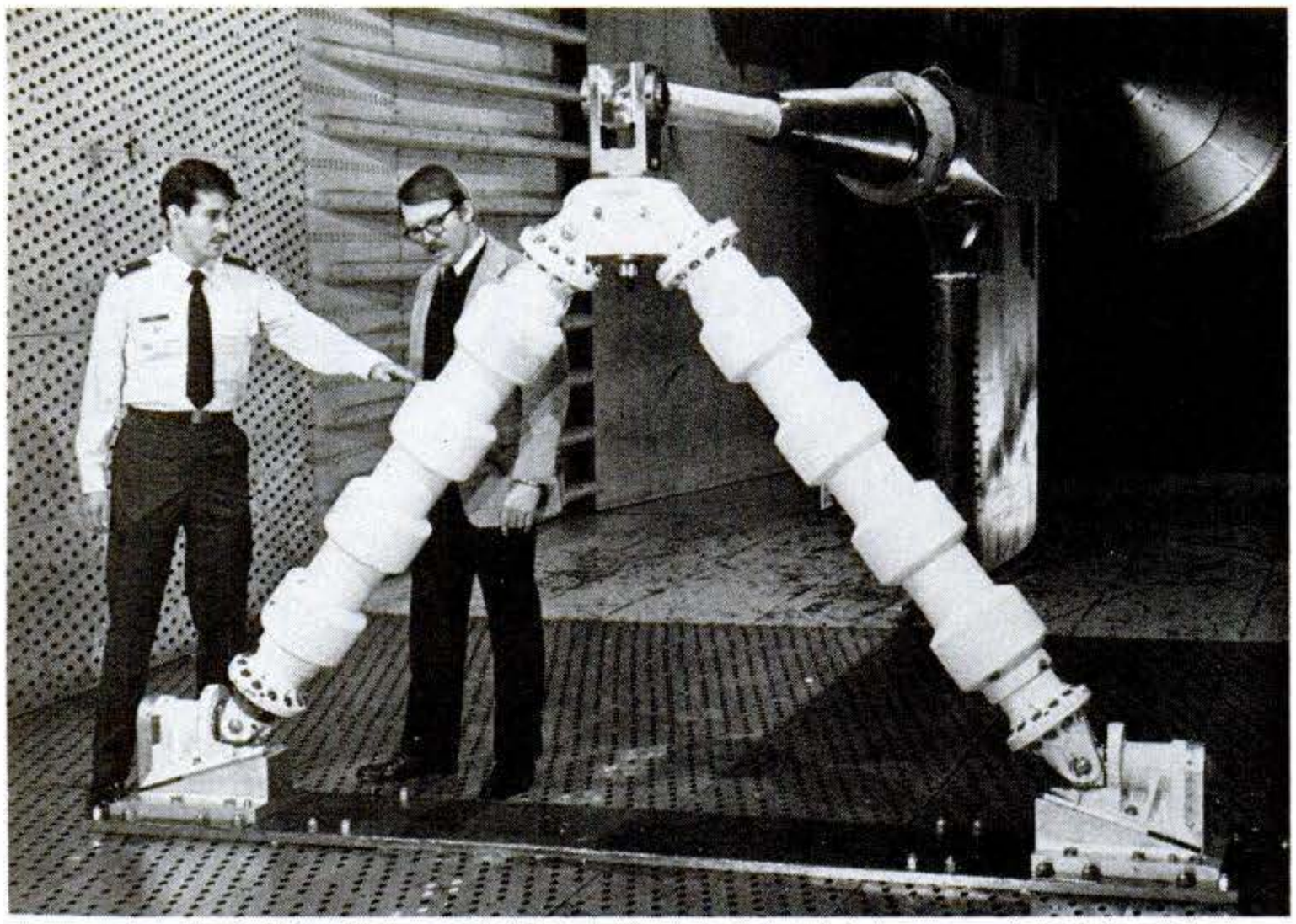
SCIENCE NEWSFRONT

By ARTHUR FISHER



Space Shuttle bipod test

What looks like a nutcracker for a very large robot is actually the sole mechanical connection between the nose of the Space Shuttle orbiter and its 154-foot-tall external fuel tank—a vital link indeed. During the Shuttle's launch and ascent through the atmosphere, the V-shape bipod will be subjected to furious air currents and vibrations caused by the aerodynamic condition known as "vortex shedding." To test the bipod's ability to withstand such buffeting, engineers at the U.S. Air Force's Arnold Engineering Center in Tennessee placed one in their transonic wind tunnel, as shown in the photo above. The component was put through a "Mach sweep" with wind speeds ranging from Mach 0.15 to 1.4 (114–1062 mph). The tests showed that immunity to potentially dangerous vibrations could be improved by a simple modification: applying collars made of spray-on foam insulation to the bipod's two aluminum struts.

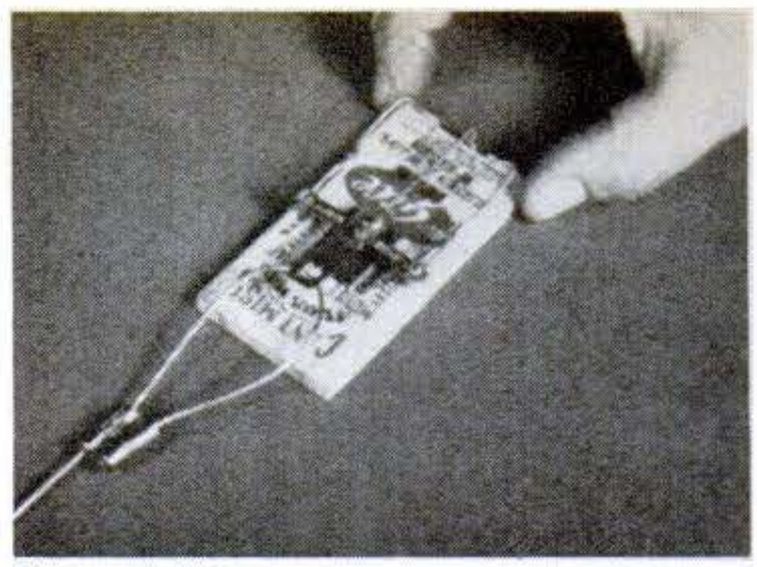
Solar-flare service

A unique hotline is now available to anyone who wants to keep informed about the sun's behavior during this year of peak solar activity, the so-called "solar max." The telephone Solar Max hotline service originates from NASA's Goddard Space Flight Center in Greenbelt, Md., and is provided jointly by NASA and the National Oceanic and Atmospheric Administration through NOAA's Space Environment Services Center in Boulder, Colo. Recorded messages that are updated daily will report on solar flares—which have the potential to cause geomagnetic storms that can disrupt electronic communications—sunspots, and other aspects of the sun's ever-changing visage. The number is (301) 344-8129.

The recordings originate in the Solar Maximum Mission's Experiment Operations Facility, under the supervision of NOAA forecaster David Speich. The Solar Maximum Mission spacecraft is an Earth-orbiting solar observatory that was launched last February. The recordings will report on experiments being carried out aboard the craft, as well as giving the locations of active regions on the sun. The information will be used by astronomers, amateur radio operators, geologists, and others who follow the solar cycle. Scientists are coordinating the observations made by the Solar Maximum Mission spacecraft with those from ground-based observatories in the most comprehensive investigation ever of solar flares.

Superpower windmill

A one-million-dollar windmill with an output of two megawatts has been built by Mehrkam Energy Development, Inc. [PS, April '79] in Reading, Pa. The really surprising thing about this turbine, the most powerful to go on line so far in the United States, is that it was built without government funds. The firm of Metals Engineering, Inc., which acquired the windmill, expects it to pay for itself in seven years. The machine has six 55-foot blades on a 100-



foot tower, and is designed to generate electrical power in nine-mph winds.

Build a better mousetrap

But not for catching mice. In fact, this primitive apparatus, and others equally simple, have been devised by an ingenious inventor with the U.S. Department of Agriculture Forest Service. Earl Olson, an environmental geologist, has designed at least six devices for detecting landslides. Although they are built from 100 different kinds of household hardware, including mousetraps, tongue depressors, nuts, bolts, nails, and measuring tapes, these devices compete with delicate and expensive electronic equipment. Olson says that people refer to him as the "junk man," and adds, "They laugh when they see what I'm using, but most are impressed by the results. They're amazed, for example, that two tongue depressors glued to a clothespin can show that several tons of earth have shifted." Forest Service managers depend on Olson's data to establish the stability of land for building roads, developing ski and other resorts, making sales of timber, and protecting visitors to National Forests.

Superalloys for jets

Development of a new ceramic material by engineers at General Electric has made possible the casting of hollow jet-engine components from some of the toughest, most heat-resistant alloys known, with a significant gain in fuel economy. The three members of a GE team in the photo below are holding a core made of the new

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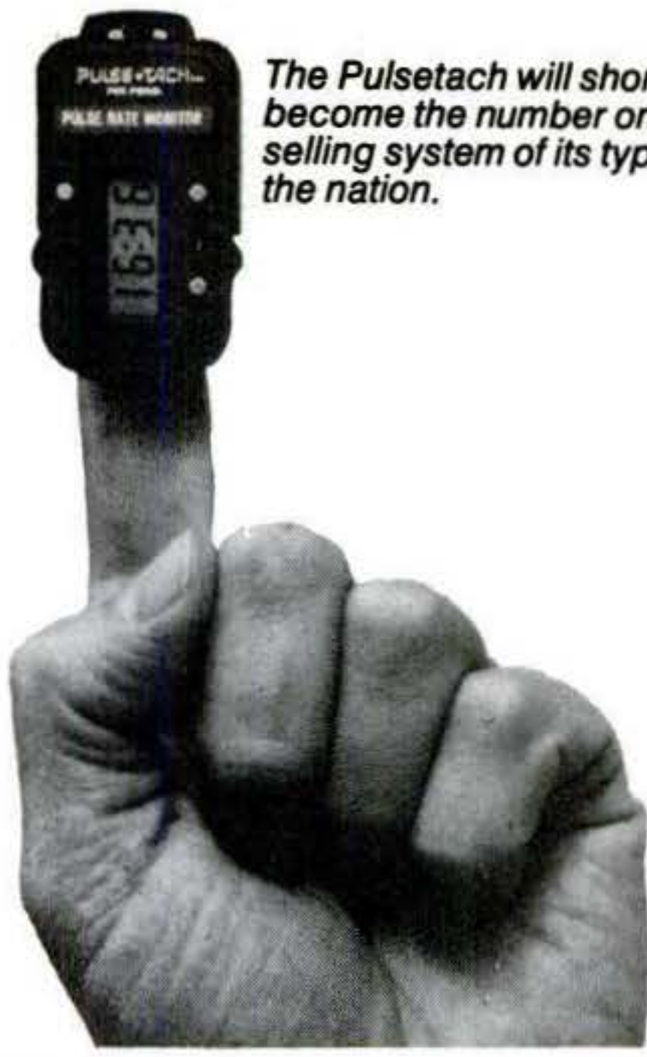
Heart Computer

Your heart can tell you three things that can help you live longer and stay healthier. The rest is up to you.



The Pulsetach will shortly become the number one selling system of its type in the nation.

JS&A has never offered a pulse meter. And for good reason.

If you've ever used one, you'll quickly discover that your heart does not beat like a clock. It's irregular. It might beat at 40 beats per minute for one instant and at 120 the next. Since most pulse meters measure each beat as it occurs, you never feel confident that you're getting a very good reading.

We also considered size. Each pulse meter we examined was large or cumbersome and awkward to carry or store.

WE WAITED

We waited a few years. In the meantime, we discovered three ways your heart (through your pulse) helps you monitor your health.

Pulse Rate Your pulse rate can tell you if you are getting enough oxygen throughout your body. A high pulse rate indicates that your heart must pump faster to supply that oxygen and may indicate poor physical condition.

Target Zone Your pulse can tell you if your heart is beating fast enough during exercise. There's an area called the "Target Zone." Below this level, you're not exercising hard enough to do your heart or respiratory system any good. Above this level, you can be dangerously over-exerting yourself.

Cardiac Recovery Time The time it takes for your pulse rate to return to normal after you've exercised is the real measure of whether or not your exercise program is doing you any good. This time can be as healthy as one minute or as poor as several minutes.

The three things we learned convinced us that the ideal pulse meter must have the following features:

1. It must measure a series of heart beats and simultaneously compute the average to avoid the strange readings from irregular heart beats.

2. It must be small enough to use while exercising.

3. It should have a timing capability to determine the Cardiac Recovery Time.

It wasn't until a small Utah medical electronic instrument company created what we feel not only provides the capabilities listed above, but excels in other areas too.

FITS ON FINGER

The unit is called the Pulsetach, and it fits right over your finger. It weighs less than an ounce and can be worn easily during most exercise programs.

The large liquid crystal display can easily be seen in normal room lighting or in bright sunlight, and because liquid crystal displays consume very little power, the readily-available watch batteries will last for years. The Pulsetach automatically turns itself off in five minutes if you forget.

The heart of the system is a powerful microcomputer CMOS semi-conductor integrated circuit that will take up to 4 pulse beats, compute an average pulse rate, and then flash that rate on the liquid crystal display.

FINGERTIP SCANNER

The sensor consists of a Gallium Arsenide infrared light-emitting diode which scans your fingertip hundreds of times a second to determine your pulse rate. This new system is one of the most accurate and is also used in sophisticated hospital systems.

The unit also contains a quartz-controlled timing circuit which will accurately time either your exercise period or your Cardiac Recovery Time. And you can switch back and forth between the pulse and chronograph mode while you are exercising.

We realize that the Pulsetach sounds like a very sophisticated unit. And it is. But as sophisticated as it is internally, it's an extremely easy unit to operate. There are just two buttons to press which operate the pulse reading and the chronograph timing circuit. A third button engages the audio circuit.

The Pulsetach system fits comfortably on your finger while it monitors your heart and determines your Cardiac Recovery Time.

HEAR YOUR PULSE

The audio circuit simply beeps every time your pulse beeps. This feature lets you monitor your pulse by hearing it as you run or exercise and it can be shut off by pressing the button a second time. The timing circuit is quartz-controlled and extremely accurate.

The Pulsetach not only has combined all of the most advanced technology in an extremely small size, but it costs less than many other systems lacking its advanced features.

The Pulsetach can be used for joggers, athletes, all forms of exercise and even cardiac recovery patients, as it operates quite effectively with pacemakers.

REAL WORKOUT

We suggest you order a Pulsetach for our 30-day no-obligation trial. When you receive your unit, give it a real workout. Notice how simple it is to operate and how easily you can read your pulse rate. Use it to stay in your Target Zone and to determine and then improve your Cardiac Recovery Time.

Monitor your Cardiac Recovery Time. Determine your Target Zone and see if you're really exercising in that area. Then use the Pulsetach to watch those important signs slowly improve thanks to the accuracy and information you get from the unit.

By knowing the important factors that help you monitor your health, you'll feel better, exercise more effectively, and many doctors feel you'll live longer.

TWO UNITS AVAILABLE

To order your Pulsetach pulse meter, send your check for **$119.95** plus $2.50 postage and handling (Illinois residents add 6% sales tax) to the address below. (Allow 20 days for personal checks to clear.) Credit card buyers may call our toll-free number below.

You can also order the more expensive hospital unit that averages 16 beats and has all the features including the small size of the previous unit. It costs **$169.95**.

We'll send your Pulsetach pulse meter complete with 90-day limited warranty and instructions which include information on determining your Target Zone, Cardiac Recovery Time and other helpful information.

Then after your test, if you're not fully convinced that the Pulsetach is the best unit of its kind, the most convenient, and the greatest value, return it within 30 days for a prompt and courteous refund including the $2.50 charge for postage and handling. You can't lose.

Your Pulsetach is totally solid-state so service should never be required, but if it is, the manufacturer has a national service-by-mail facility backing each unit. JS&A is America's largest single source of space-age products—further assurance that your Pulsetach is backed by a substantial company.

We've waited an awful long time to jump into the pulse monitoring field. But what a great entry. Order your Pulsetach at no obligation today.

JS&A® PRODUCTS THAT THINK®

Dept. PS One JS&A Plaza
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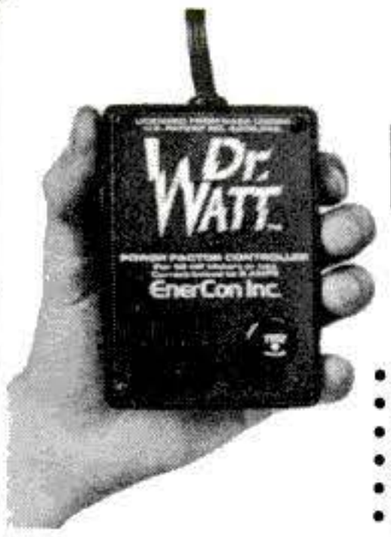

NASA Power Saver

- NASA Patent # 4,052,648
- UL Listing Applied For
- 15% Energy Tax Credit
- Built-in Safety Fuse
- Cooler, Quieter Motors
- Load Compensation to Prevent "Bog Down"

NASA invented it to save power in spacecraft. Now, YOU can use it to cut the cost of using major appliances by as much as 60%.

In 1975, NASA engineers invented a computer to conserve power used in spacecraft. They called it a power factor controller. Selected companies were licensed to produce it. Exxon bought Reliance Electric for it. One company, Enercon, Inc., further modified and improved upon that design for home and industrial applications. They call it Dr. Watt.

HOW DR. WATT CUTS POWER

Most electrical motors found in major home appliances were designed to supply maximum power during peak load conditions. Your appliances typically do not need all this power most of the time. During these periods, these motors use more power than is necessary. NASA invented a solid state device that senses when your appliance is overloaded; it then switches off the power for very short periods of time (millionths of a second). When demand for power increases, Dr. Watt provides more. You use and pay for only the energy you really need. It's like letting up on the gas when your auto is coasting downhill.

CHECK THE SAVINGS

Dr. Watt applies to induction type electrical motors, the most commonly used in major home appliances and industry. Dr. Watt can save 10 to 60% depending upon load.

Application	Monthly Cost	*Monthly Savings
3 Ton Central Air Conditioner	$89.10	$13.37
Washing Machine	$11.40	$ 3.99
20 Cu. Ft. Refrigerator Freezer	$17.60	$ 2.64
Shop Disc Grinder	$12.00	$ 7.20

*Average monthly savings are based on National Energy Watch data and estimated usage figures.

Dr. Watt savings can be substantial. It may pay for itself in weeks. You also get a 15% energy tax credit off your income tax. Don't take our word for it—test one at no risk for yourself.

NO INSTALLATION REQUIRED

Dr. Watt is easy to use. Simply plug Dr. Watt into your wall outlet, plug your appliance into Dr. Watt and start saving. Dr. Watt also comes in wire-in models for industrial application.

15 DAY NO-RISK TRIAL

Try it for 15 days, if you are not completely satisfied, return it for a prompt refund of your purchase price. After that, you have a substantial factory warranty.

TO ORDER send check or money order to the address below. Credit card customers:

Call Toll Free 1-800-527-7066

In Texas call collect (214) 349-3120

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Yes send me the following Dr. Watts with 15 day no-risk return.

___120v ½h.p.Dr. Watt	$39.95
___120v ½hp Wire-in	$59.95
___120v 2hp Heavy Duty	$79.95
___240v 5hp Heavy Duty Wire-in	$79.95
___240v 5hp Heavy Duty Plug-in	$99.95

Add $2.50 for delivery. Texas residents add 5% sales tax.

Name_____

Address_____

City_____

State_____Zip_____

☐Check of M.O. Enclosed

For even faster service, charge to:

☐MC/Visa — Expires_____

Account #_____

Signature_____

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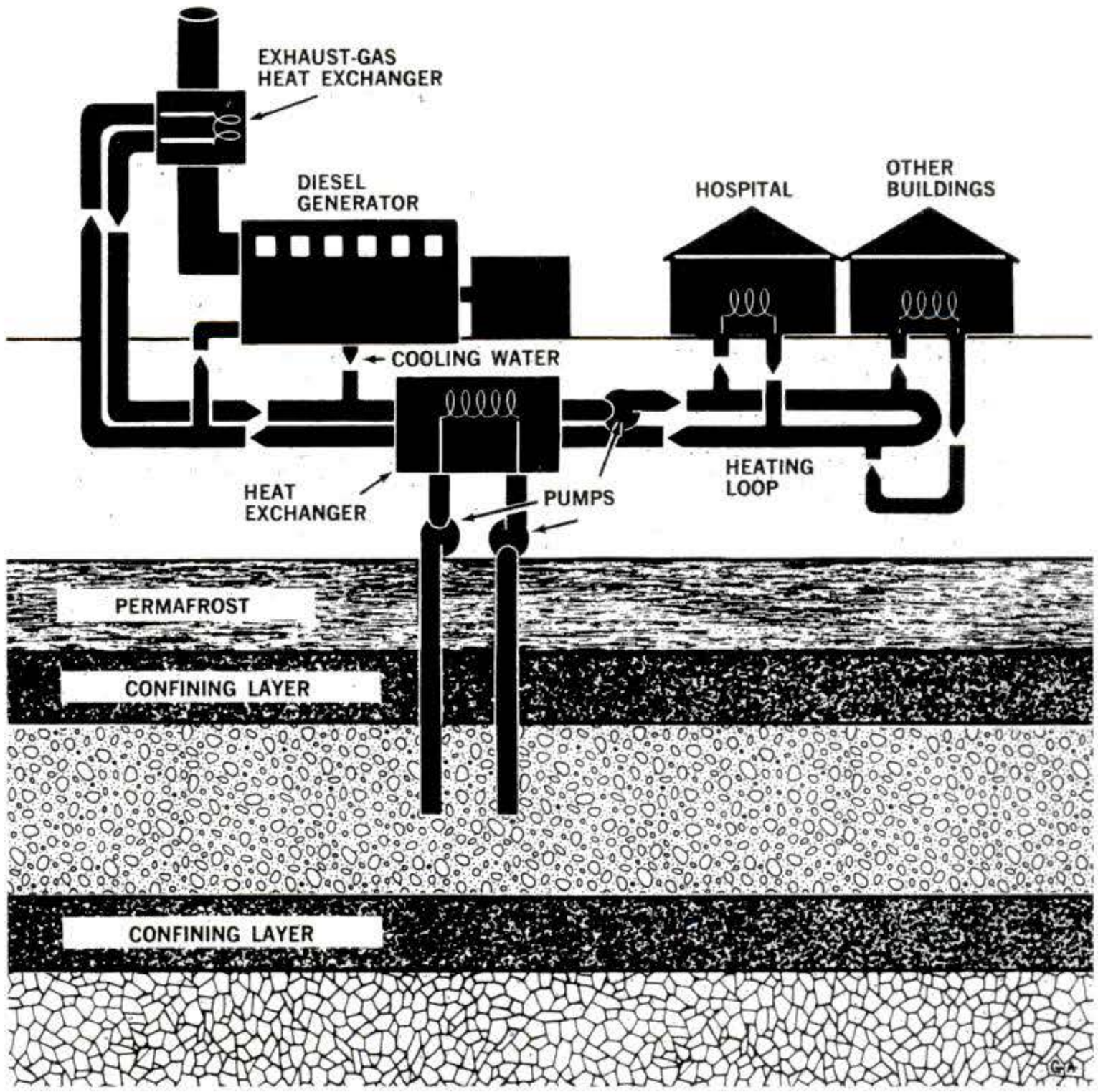

Koralox alumina ceramic. The core is used in a mold into which the molten alloy is poured. After the metal—called an advanced oriented eutectic alloy—has hardened, the intricately shaped core is chemically dissolved away. This leaves a component with complex cooling channels for the compressed air that cools turbine blades on jet aircraft. Engines with the supertough, superalloy blades could have as much as 17 percent more thrust than those with more conventional blade materials.

Storing waste energy in water

Improvements in generation and conservation are two prongs of our attack on the energy crunch. A third important one is energy storage. Now the Department of Energy has launched a study to determine the engineering and economic feasibility of storing waste energy in aquifers—underground bodies of water. Under the management of Battelle Memorial Institute, the Aquifer Thermal Energy Storage Program will examine three sites: in Alaska, New York, and Minnesota. The drawing shows how the system would work at one of them, in Bethel, Alaska. During warm summer months, water would be pumped from the underground aquifer and heated by exhaust gas from the town's diesel-powered electric generator. Then it would be pumped back below ground and stored until winter, when it could be retrieved to heat some of the town's buildings. Heat exchangers protect the aquifer from contamination. The Bethel system will be designed by TRW to heat the water to about 200 degrees F. In the ATES approach, only confined aquifers—those insulated above and below by impermeable layers of earth—will be considered.

Improved solar cell

Materials scientists at Boeing Aerospace Company's Engineering Technology organization have advanced the state of the art of thin-film solar cells. They have developed a cell with a sunlight-to-electricity conversion efficiency of 9.4 percent, under contract to the Department of Energy's Solar Energy Research Institute (SERI), which views the achievement as a major advance. The prime goal of this country's National Photovoltaic Program is to produce thin-film solar cells with efficiencies of at least 10 percent. According to Dr. Sayten Deb, SERI's Photovoltaics Division program manager, optimal design of the cell should soon push the efficiency to more than 10 percent.

Thin-film solar cells consist of a very meager film of photovoltaic material deposited on a low-cost substrate. In the Boeing cell, the film is made of copper indium selenide/cadmium sulfide. Such cells are being sought as an alternative to present-day single-crystal silicon cells. These have a conversion efficiency of 15 percent, but are so difficult to make that they cost about $10 per watt. Thin-film solar cells with an efficiency of 10 percent should cost less than 50 cents per watt by 1990. PS

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AT LAST. MESSAGES FROM ANYWHERE FOR ONLY $179.

A few years ago, when remote message retrieval made its first appearance in a handful of $300 telephone answerers, people figured that was the price they'd have to pay to hear messages long distance.

Unfortunately, since then remote playback has continually proved to be one capability you *wouldn't* find in an inexpensive phone answerer.

But now you will. Because the engineers at Phone-Mate® have defied both the laws of traditional design and inflation—with a fully capable remote answering system that's priced even lower than many units lacking this extraordinary feature.

Introducing Phone-Mate's newest genius, the Remote 905.

Make one announcement, not 30.

Phone-Mate's remote pocket coder enables you to hear your messages from any corner of the world—just by beeping into the nearest phone, anytime. And its designers have even gone to the trouble of protecting the privacy of your messages: the playback function will only respond to the exact frequency of its matched pocket coder.

But this very useful talent is only one of many exceptional phone answering features.

Take, for example, its dual tape design (other low priced answerers try to get by with one). It stores your outgoing announcement on one tape, incoming messages on the other. Meaning you record just one personal announcement instead of 30 (as required on single tape units). And eliminate the aggravation that comes with hearing an announcement every time you play back a message.

What's more, you can record up to 30 half-minute incoming messages on the unit's trouble-free cassette. Then flip it over for another 30. Or pop it in and out—instantly—for easy storage or replacement.

To hear those messages, you'll take advantage of the 905's remarkable Audio Scan™ system—the same feature found on Phone Mate's most exclusive models. It actually lets you hear messages in rewind or fast forward. Even helps you count them. And assists in rapidly pinpointing the one you want.

To answer or not to answer. That is the option.

More reasons why it's easy to mistake this $179 phone magician for one of its more expensive competitors?

Its incoming call monitor, for one. It lets you hear your caller's voice *before* you pick up the phone. Allowing you to effectively screen out untimely calls—yet never miss a message (or a business order, or an important reply).

Then there's the Message Received light that tells you at a glance whether anyone's called. The Power On light that lets you know your unit's ready for action. And for keeping track of announcement length, a built-in precision timer.

Phone Mate's newest. The first dual tape remote answering machine available at this remarkably low price. Order yours now with a free phone call to The Sharper Image.

By the way, for those who may be considering a month-to-month answering service, you should know this: after initial connection and less than half a year of service fees, you will have paid out considerably more than the cost of this new Phone-Mate.

Reserve yours now.

It's no secret that Phone-Mate has long secured its position as the industry's leader.

What's more, we believe that their newest machine possesses talents no other inexpensive answerer can match. And we consider ourselves lucky to have been chosen as one of the first to bring it to the public.

All things considered, we expect this electronic genius is going to be in short supply at most stores; yet by ordering now through The Sharper Image, you can be assured of receiving the 905 even before many stores get their hands on it. A single toll-free phone call is all it takes to confirm your order.

You'll also have the luxury of using remote message retrieval for two weeks without obligation. If not completely delighted, just return it for a prompt, courteous refund (including the $3.50 delivery charge).

Incidentally, all Phone-Mates are backed by a substantial network of service centers (though it's highly unlikely you'll ever need one). Also included are its built-in microphone, operating manual, cassette, and one-year parts, 90-day labor warranty.

So reserve yours now. And own the one remote phone answerer that leaves nothing to be desired.

ORDER NOW TOLL FREE.

Order product #248. Credit card holders may use our toll free number below. Or send check for $179 plus $3.50 delivery (in California, add $10.74 sales tax). Please mention this magazine.

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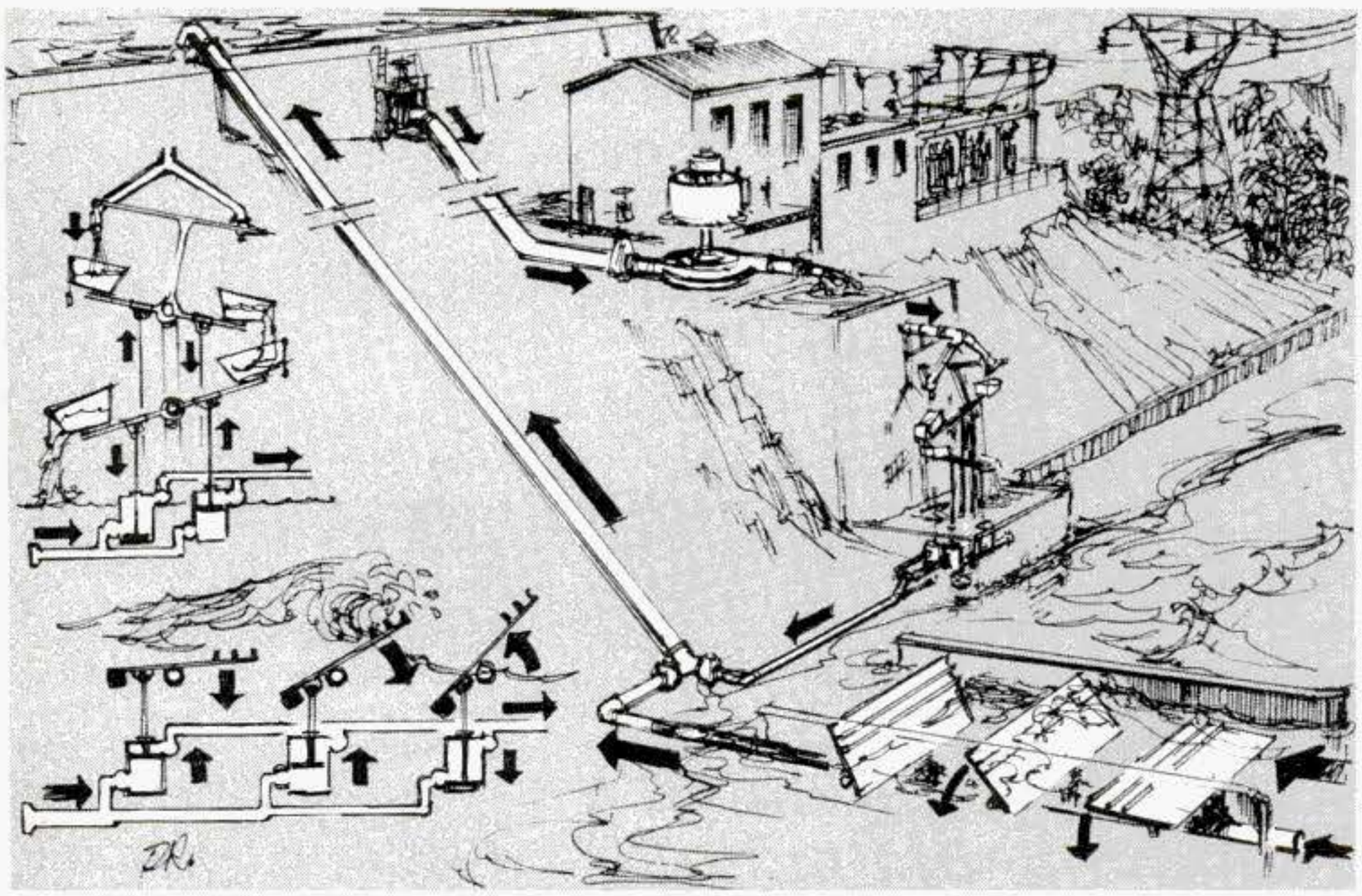
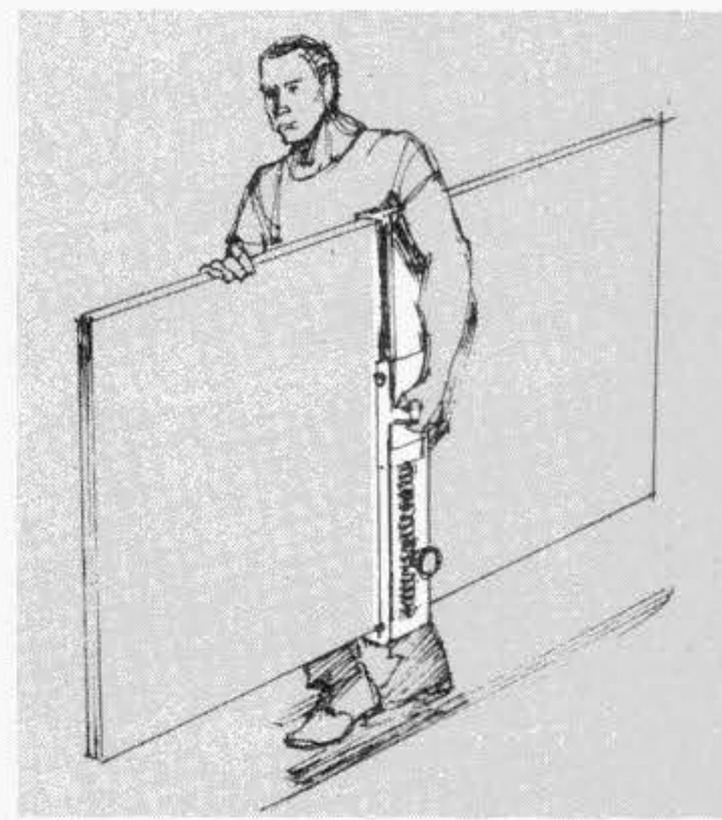
NEW IDEAS FROM THE INVENTORS

ILLUSTRATIONS BY DANA RASMUSSEN



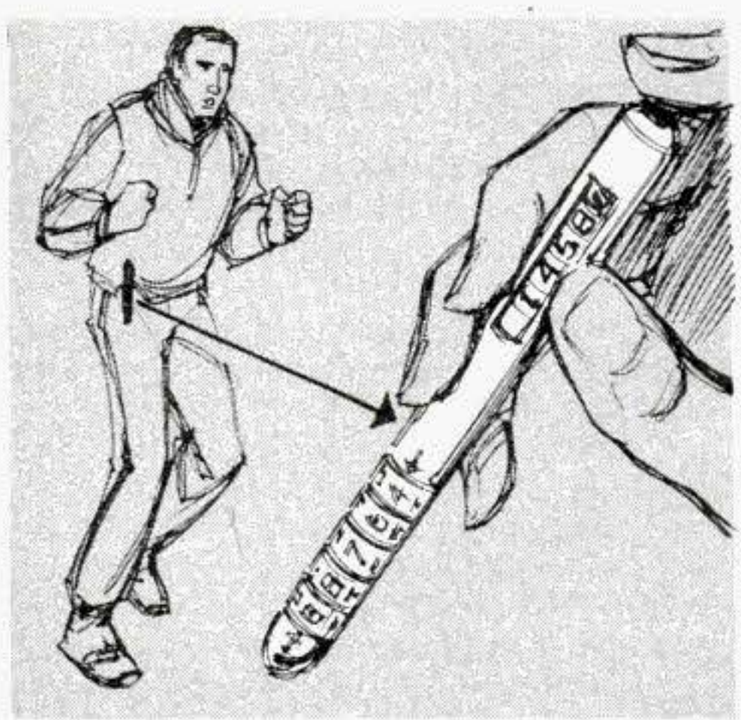
Waves help power stepped, stored-water generator

Many shore locations have abundant power for hydroelectric generation, even if they lack elevated or fast-flowing natural rivers, says this inventor. He'd build a holding tank at a convenient height, and two generators along the downslope. Wave-action pumps below and collector buckets on a "walking beam" pump would lift water to the reservoir. Downflow would be split into two streams, one to power the upper turbine, the other to power the larger, lower turbine.



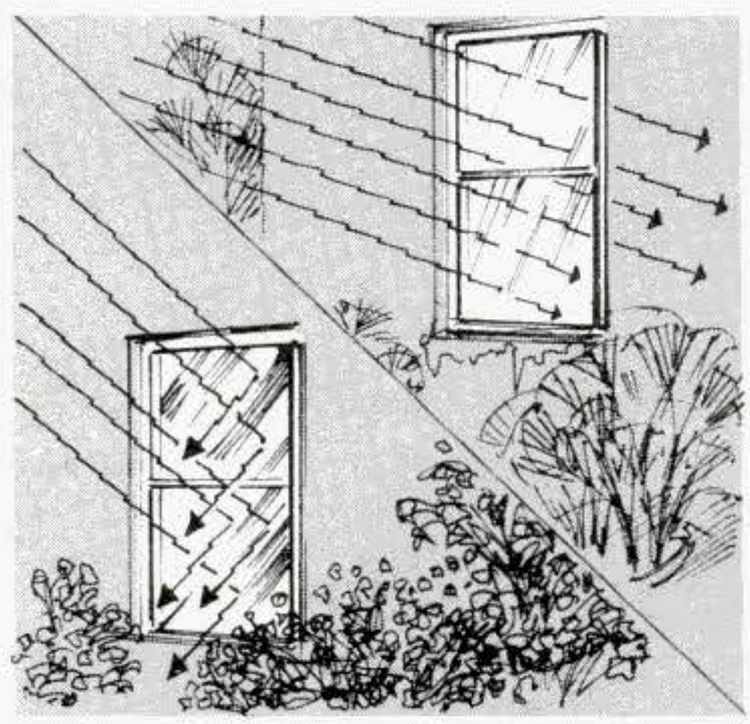
Handled frame grips panels

It's not the weight that makes it so difficult to carry wallboard, plywood, and other standard-size panels, but rather the near impossiblity of getting your arm around them. This telescoping, spring-retracting carrying frame could ease the task of lugging panels to a job. With gripper projections slipped over the panels' edges, the retracted frame would hold them tight and provide a carrying handle.



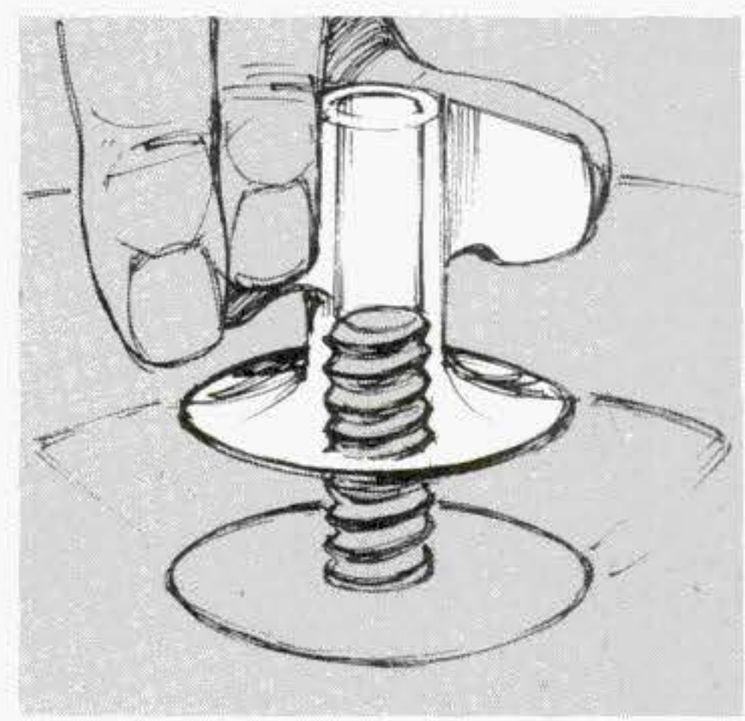
Calculator figures calories

After dialing in such individual data as your height, weight, age, and sex, you'd clip this computer to your clothing and go about your exercises or normal business. An electronic vertical motion sensor and timer would then figure out, according to a preprogrammed formula, how many calories your activity burns up over a fixed period and display the answer.



Coated window saves energy

Ordinary window glass in this storm window would be coated on one side with a radiation-absorbing film, which in turn would be covered with a radiation-reflecting film. With the window installed so the films face outdoors, it would partly block warming sunlight in summer. In winter you'd reverse the window to admit radiation and keep heat inside.



Plastic wing nut taps itself

Finding the right fastening for some low-stress parts or attachments might go a lot faster if you kept a supply of these plastic wing nuts on hand. The durable, heat-resistant nut would be shaped with a flared mouth and surrounding collar to fit a range of stud sizes. You'd tap the nut by screwing it on a threaded stud. It could also speed assembly-line operations.

The following patents have been issued on these inventions: **Wave-powered generator**—No. 4,132,901 to Don Crausbay, St. Thomas, Virgin Islands; **Calorie computer**—No. 4,192,000 to Elmer M. Lipsey, McLean, Va.; **Reversible window**—No. 4,180,954 to Harold A. Gell Jr., Silver Spring, Md.; **Panel gripper**—No. 4,135,655 to Averil L. Brown, Corning, Calif.; **Plastic wing nut**—No. 4,114,506 to Michele Aimar, Turin, Italy.

Copies of patents may be ordered, by number, from the Commissioner of Patents and Trademarks, Washington, D.C. 20231, at 50 cents each. To write to an inventor, if address above is insufficient, address him by name and patent number in care of the Commissioner.

UNDISCLOSED SOURCE

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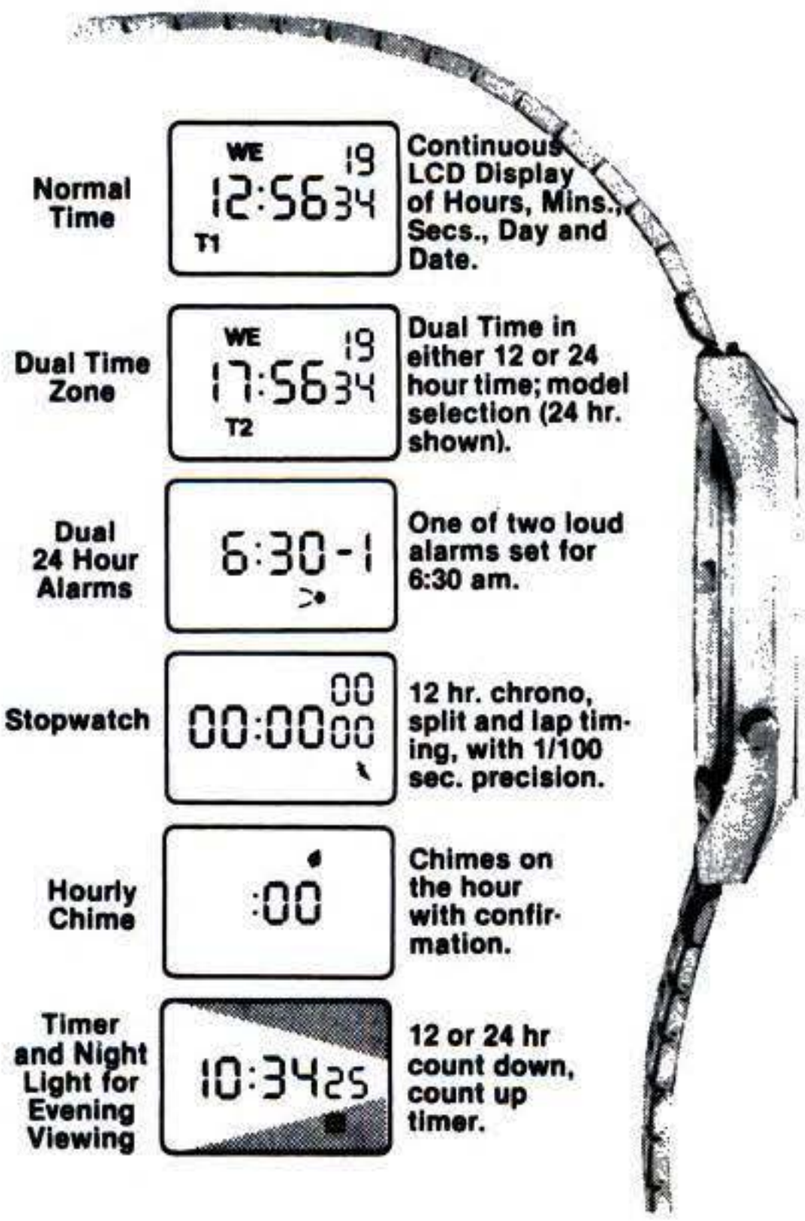
Now, the closely held secret behind many of today's quartz timepieces is revealed.

Most major companies would rather have these facts remain secret, but one little-known company decided to show its genius to the world.

To effectively compete in world markets and when lacking in necessary technology, many major companies have turned to smaller more dynamic companies to build their products. Sometimes the product is built to the specs of the major company. But more often than not, the only unique parts are a label and different owner's manual. This practice is quite prevalent in the digital watch industry.

One company that has been the real source behind products introduced in the U.S. by companies like Mattel, Timex and Texas Instruments, is Olympos Electronic Co., also known as Otron.

Olympos Electronic now wants the world to know its name and genius. We feel lucky to be selected to bring this story to you.



Olympos Electronic Co. is now introducing products into this country under its own trade name—Otron. We are introducing one of the first Otron products into the U.S.

12 or 24 HOUR DUAL TIME, DUAL ALARM CHRONOGRAPH

The first product we selected is the Alarm Chrono X watch. It may be the most advanced Quartz timepiece in the world today for under $200.

We know of no other watch that combines these unique features and design. It has both a 2nd time zone capability and a 2nd separate alarm. It comes in either 12 or 24 hour version. These features are just the beginning. Compare this watch feature-for-feature against any other in the world. We believe you will be convinced that there is not a better watch dollar-for-dollar anywhere.

TESTED TO 100 FEET OF WATER

Three years ago, there were no digital water resistant alarm watches. Today they exist in some more advanced models, but cost $100, $200 or more. Our Alarm Chrono X is submersible to 100 feet of water. Its unique alarm emits sound right thru the stainless steel case. The O-ring construction and rock hard mineral glass lens provide a lock tight seal against water to 100 feet—it's guaranteed.

THINNESS AND BOLD MASCULINE DESIGN

The Alarm Chrono X is a combination of bold masculine design and just the right degree of thinness. No sacrifice in function or masculinity, the Chrono X measures 8.9 mm from the top of its mineral glass lens to the back of its stainless steel case. That's 1.6 mm thinner than the popular Seiko Alarm Chronograph, 2.1 mm thinner than the Citizen and 3.1 mm thinner than Texas Instruments. Yet Alarm Chrono X has the same bold design of each. The Seiko sells for $250; the Citizen for $200; and the T.I. for $125. . .What does Otron know that these other companies don't?

UNSURPASSED QUALITY AND ACCURACY FOR UNDER $70

Stainless steel case, and finely woven mesh bracelet, mineral glass lens, water resistant to 100 feet and quartz accuracy to ± 5 seconds per month. That's quality and accuracy found only in watches costing $200 or more. The Alarm Chrono X sells for $69.95 in stainless steel case and $79.95 in gold with 3 microns of real gold over stainless. Compare features and price for yourself before you call to order.

ORDER TOLL FREE AT NO-RISK

The Alarm Chrono X is offered with a 15 day no-risk trial period. If during 15 days, you find the Alarm Chrono X not to your liking return it for a prompt refund of your purchase price.

In the unlikely event that anything should go wrong after the trial period, your Alarm Chrono X is backed by a full year warranty thru Otron's Service by mail repair facility in this country.

To order your Alarm Chrono X fill out the order form below and send it with check or money order to us. For faster service, credit card customers call Toll Free 1-800-527-7066. Don't wait — order today to insure getting a watch of this quality, with these functions, at this price.

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Please send me the following Alarm Chrono X watch(es) with a 15 day no-risk return privilege at $69.95 each, plus $2.50 delivery. Texas residents add 5 % sales tax.

_____Stainless Steel _____Gold $79.95

☐ 12 Hour time ☐ 24 Hour time

Name _____

Address _____

City _____

State_____ Zip_____

☐Check or M.O. enclosed

For even faster service, charge to:

☐MC/Visa Expires_____

Account #_____

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Order Toll Free **1-800-527-7066.**

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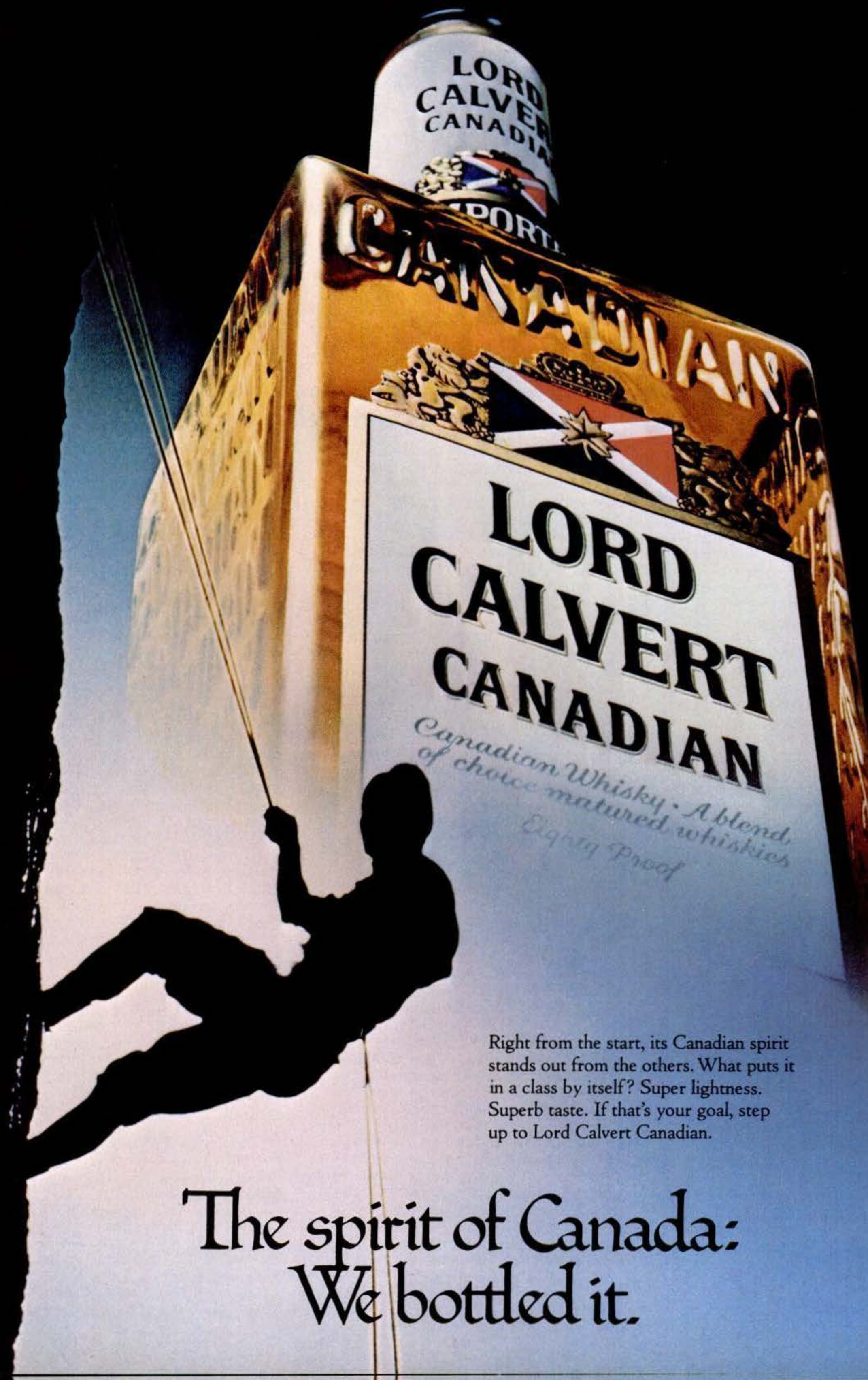
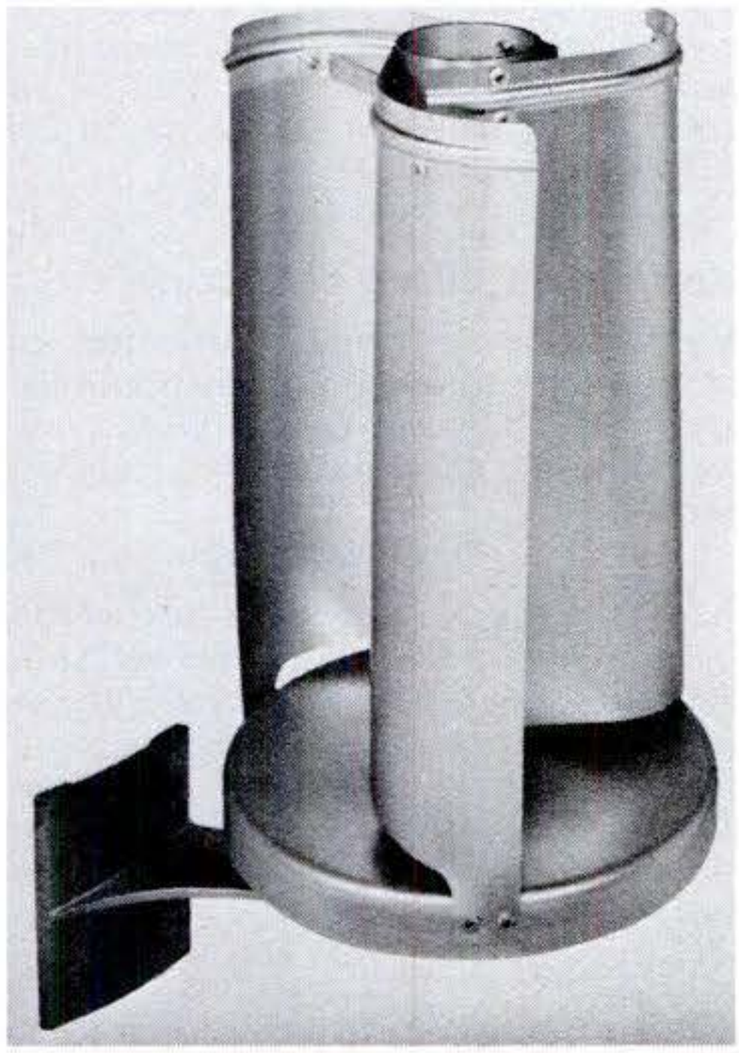


Right from the start, its Canadian spirit stands out from the others. What puts it in a class by itself? Super lightness. Superb taste. If that's your goal, step up to Lord Calvert Canadian.

The spirit of Canada: We bottled it.

RECREATION ROUNDUP

By HERBERT SHULDINER

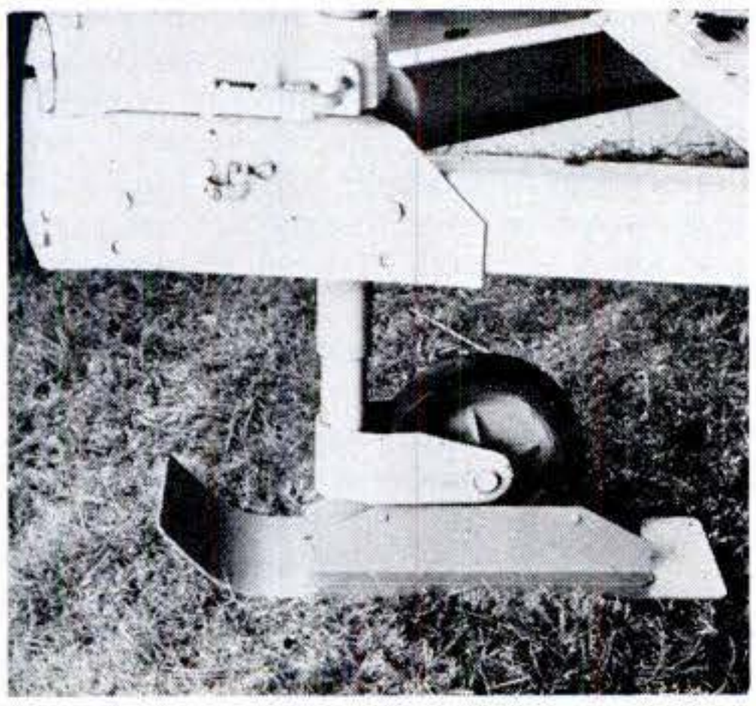


Battery-charging windmill

When you're parked at a campsite for a long time, there's the possibility of completely discharging RV batteries. The Eodyn Wind Charger generates enough power to trickle-charge RV batteries with even a slight breeze. Its daily charging rate is three ampere-hours in average wind conditions (10–12 mph). A bridge rectifier converts generated AC current into DC to charge the batteries. The Eodyn 200 with two-battery capacity costs $490. The Eodyn 400, which can charge four batteries, is $880. From McBride International, 157 Sisson Ave., Hartford, Conn.

Trailer-wheel support

If you've experienced problems trying to keep a trailer level in a muddy campsite, this wide, ski-shape steel skid could help. The skid fits under the trailer's nose wheel



and keeps it from sinking into mud or sand. It's made by Desmo Ltd., Coleman Products Division, Pensnett Trading Estate, Brierly Hill, West Midlands DY6 7NR, England.

Seat belts in RV's

Many motor homes that can accommodate six to eight passengers have frequently rolled off factory assembly lines with only two seat belts. A revised standard of the Department of Transportation, which went into effect last September, should end this practice. Revised standard 208 requires a belt for each advertised sleeping position.

Cat championships

The Hobie Cat world championships will be held this month in Christiansted, St. Croix, Virgin Islands. Contestants from 28 countries are expected to compete from November 16 to 22. At the same time, the 10-event Hobie Olympics will take place at Christiansted.

Mini stuff sack

A small stuff sack from Coleman, designed for carrying its Peak 1 backpacking stove, is a versatile camping aid. I've

found it handy for protecting fragile items like cameras in a backpack. The quilted sack is lined with a cushioned foam material that helps absorb potentially harmful shocks. The stuff sack is available at sporting-goods stores for about $6.95.

Fuel pourer

Coleman's new pourer makes fueling camp lanterns, stoves, and catalytic heaters easier. Screw the pourer onto a fuel can's spout, insert it into the fuel tank, and pour. It automatically stops when the can is full because there are two passages built into the pourer (see cutaway photo): One is an air passage and the other a fuel passage. As long as air is escaping from

the filling tank, fuel keeps pouring into it. When air stops, so does the fuel. The pourer costs about $2. It's a lot more convenient than using a funnel, which usually causes spillovers.

Changing RV patterns

Recreational-vehicle owners are adjusting to higher gas prices and small cars by buying smaller campers and making trips closer to home, according to Don Lowe, senior vice-president of Kampgrounds of America. Lowe says the recession is accelerating the trend started by rising gas prices. A higher percentage of campers are only traveling within a 150-mile radius of their homes.

Bicyclists' palsy

Writing in the New England Journal of Medicine, Dr. Thomas A. Converse of Minneapolis, Minn., reports on a strange malady that afflicted his hands after a two-week bike trip. Dr. Converse says his hands became numb, and he experienced weakness and a loss of coordination. The affliction made it difficult for the doctor to grip a pen or eating utensils. He says the symptoms apparently resulted from "the prolonged grasp and the increased weight and pressure through the arms that characterize low-riding positions on bicycles with racing-style handlebars." The condition is diagnosed as ulnar-nerve palsy. It also affects construction workers who use pneumatic drills, carpenters who work with planes, and even secretaries who use staplers and typewriters. Dr. Converse recommends wearing gloves, padding handlebars, and changing positions often while riding to prevent the onset of this strange palsy. PS

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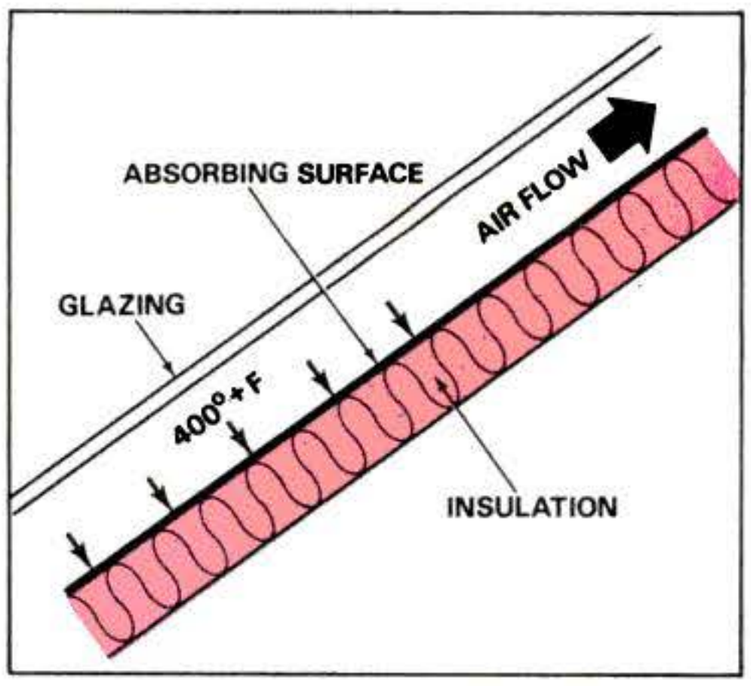
ALTERNATE-ENERGY ANSWERS

By JAN F. KREIDER

Jan F. Kreider is a consulting engineer specializing in the design and economic analysis of solar-energy and energy-conservation systems. He is the author of several books on solar technology, and a lecturer at the Univ. of Colorado.

Don't collect on wood



Could you please tell me the practicability and efficiency of using wood (painted black) as the absorbing surface in an air flat-plate solar collector?

David Post, Pomery, Iowa

Do not, under any circumstances, use wood anywhere inside a solar collector. It has been known for many years that wood exposed to high temperatures has a progressively lower and lower ignition point. A figure mentioned by the Association of Arson Investigators in the United States is 250 deg. F; that is, if the wood surface is heated above 250 deg., it will self-ignite.

If fluid flow stops in a solar collector on a sunny day, temperatures in excess of 400 deg. F are easily reached. After prolonged exposure at this temperature, wood in a collector is guaranteed to self-ignite. In one case, on May 25, 1980, a solar collector that had been shut down for several months in the high temperature stagnation condition self-ignited. The recommendations in fire codes and fire-protection-association manuals are not just theoretical, but are based upon long experience and must be adhered to when designing solar collectors for the safest results.

Real fuel costs

We are constantly being told by energy corporations about the different prices of energy. What are the actual costs and efficiencies of coal, wood, electric, LP gas, natural gas, and oil?

James B. Long
Ebensburg, Pa.

To find the net cost of fuel you must know three things: the raw energy cost, the heating value of the fuel, and the furnace or boiler efficiency. To find the first, contact a supplier. Heating values are 850–1000 Btu/cu. ft. of gas (depending on location—ask your utility), 140,000 Btu/gal. of fuel oil, 3413 Btu/kWh of electricity, 8000–11,000 Btu/lb. of coal (depending on location and quality), 95,500 Btu/gal. of LPG, 7000 Btu/lb. of wood (14–31 million Btu/cord). For comparison, a barrel of crude oil contains about 5,800,000 Btu. The third factor—efficiency—depends on the quality of equipment and its maintenance. For fossil fuels, a typical range is 50–70 percent. Electric-resistance heat is nearly 100 percent efficient, but two-thirds of the energy of raw coal burned at the power plant is wasted, so efficiency based on the raw fuel is only about 30 percent. Well-sealed wood stoves vary in efficiency from about 40 to 60 percent, while heat-circulating fireplaces are about 20–25 percent efficient.

Subtropical solar angle

My friend lives at latitude five deg. Referring to "Winter and Summer Sun Angles" in March's column, I calculate that for my friend on June 20, 1980, the sun's angle was 108.5 degrees. How can this be?

RBB (no address)

A solar altitude angle greater than 90 degrees simply means that the sun has passed beyond the overhead point and is located to the north of the observer. This always happens in summer in the tropics at latitudes below 23½ degrees. For your friend's location, the sun is 18½ degrees to the north of the overhead or zenith point.

Thermostat setback

As the owner of a home equipped with baseboard electric heat (14 individual thermostats), I would appreciate knowing if setback thermostats are available to either retrofit or replace them?

Mendel N. Silbert, Salisbury, Md.

We will soon move to our new house, which will have heat-pump heat. Will temperature setbacks at night during the winter months save money?

J. Ross Suping, Winston-Salem, N.C.

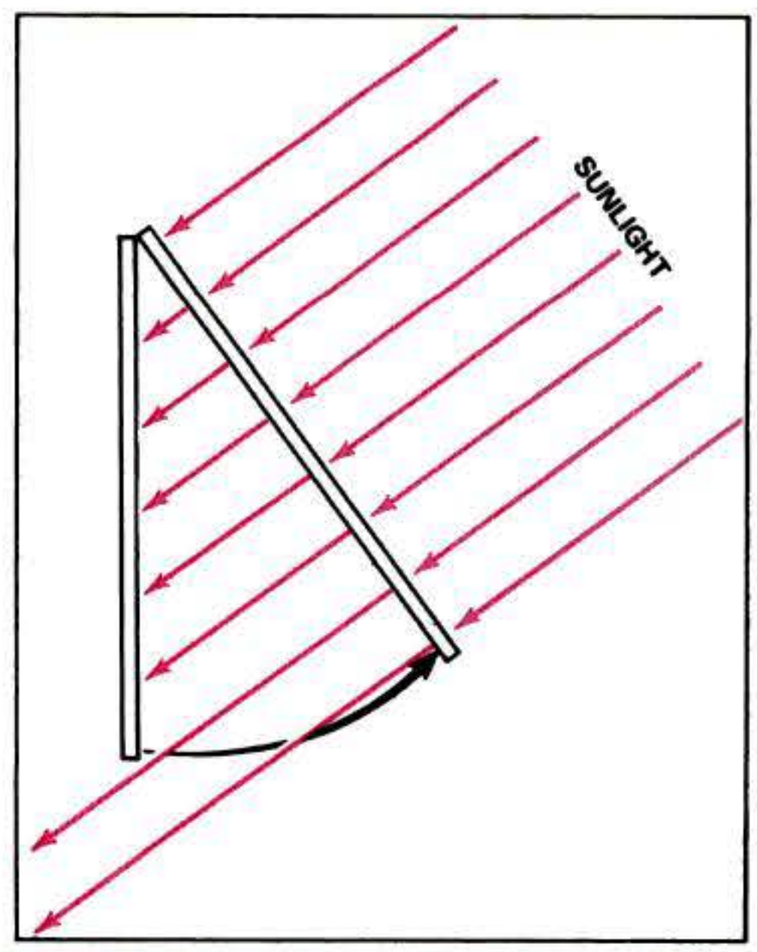
Nighttime setback is beneficial for any heating system which has an efficiency independent of environmental conditions. Therefore, gas boilers, baseboard electric heaters, and fuel-oil furnaces, for example, benefit from the use of nighttime setbacks. Typically, heat pumps do not benefit from nighttime setback. On extremely cold mornings, the thermostat will turn on expensive back-up resistance heaters because heat-pump capacity is lowest when outside air temperatures are lowest. A similar consideration applies to solar systems, since their capacity is low in the early morning after much of their stored heat is drained. To avoid bringing on the backup for these two heating systems, a time delay can be included in the control system to permit the heat pump and solar system to slowly heat up the space if possible. After the time-delay period, the backup heater may be required under severe weather conditions. Central control setback thermostats are appearing on the market (see "What's New in Home Improvement" in this issue) for homes heated by electric baseboard heat with individual thermostats. You might also check at your local electrical supply store.

Vertical vs. tilted collectors

My house is not properly oriented for rooftop collectors, so I thought about using the south-facing garage wall. What would be the effect on solar heating capacity?

Sam Barth, Fleetwood, Pa.

In most parts of the country, a vertical collector intersects 15 to 20 percent less sunlight (and may have greater losses due to reflection) than a collector with the same area tilted at the best angle for winter heating. It is possible, however, that the reduced collection could be offset by the more economical installation of a vertical collector versus a tilted collector.



Got a question on an alternate energy such as solar, wind, water, or wood? Wondering about energy-conservation techniques for home heating or cooling? Every other month, alternating with "Adventures in Alternate Energy," Jan Kreider answers selected questions from readers. Send yours to "Energy Questions," POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. Individual queries can't be answered by mail.

In the "Alternate Energy Adventure" we present a project developed or reported on by PS readers and pay $200. Submit black-and-white glossies and a sketch to "Energy Adventure" at the address listed above.

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One of the largest drains on energy is your water heater. It's sitting there constantly heating water. Even when you don't need it.

It's wasting energy. And that means money down the drain.

Timeclox Corporation has designed a 24-hour timer that allows you to pick the times when you need hot water. And automatically shut the water heater off when you don't.

Like when you're sleeping. Or during other non-peak times.

Figures from Southern California Edison indicate that the timer could save the average homeowner more than $200 a year.

While this unit only applies to electrical water heaters, a significant number of installations are no longer gas operated. Check yours.

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An additional ten percent savings may be realized by simply adjusting your water heater setting from its present 150° to 120°. Unless you have a dishwasher, the higher setting isn't needed.

But the greatest savings comes from not heating water that you're not using. And the Timeclox 24-hour timer is the answer.

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Tests run on families in Sarasota, Florida and Woodstock, Illinois have confirmed the results.

And a 35% cut in your water heater costs are guaranteed by following the recommended plan. If you are not thoroughly satisfied, return the unit within two weeks for a prompt and courteous refund.

But act now. Every day that you wait you are unnecessarily spending money that you and your family could put to better use.

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Five stylish imports

— creature comforts plus performance

PS ratings— test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	Audi 5000 Turbo	Datsun 200-SX	Peugeot 505	Rover 3500	Volvo GLE
Acceleration	5	5	3	5	5
Braking	1	2	2	0	3
Handling	2	3	3	3	3
Maneuverability	5	5	5	5	5
Quietness	0	0	0	0	1
Roominess	4	2	4	3	4
Visibility	5	4	3	5	4
Entry/exit ease	5	5	5	3	5
EPA economy	3	5	2	2	2
Ride comfort*	5	3	5	4	4

*Authors' opinion

By JIM DUNNE and ED JACOBS
PHOTOGRAPHS BY GREG SHARKO

When you move up from the economy imports to the midprice range, prices generally take an enormous leap. You certainly get more comfort, convenience, luxury, and performance, but do you get enough to warrant the usually steep price increase? To find out, we examined five midprice models. Four are four-door European sedans: Audi 5000 Turbo, Peugeot 505, Rover 3500, and Volvo GLE. The fifth is a sporty Japanese two-door hatchback: Datsun 200-SX.

Only the Audi, Rover, and Volvo are direct competitors. The Peugeot is a notch lower in price, and the Datsun is a notch below that. Rather than picking five directly competing models, we made these unusual choices so we could examine the four cars new for this year, plus the equally interesting

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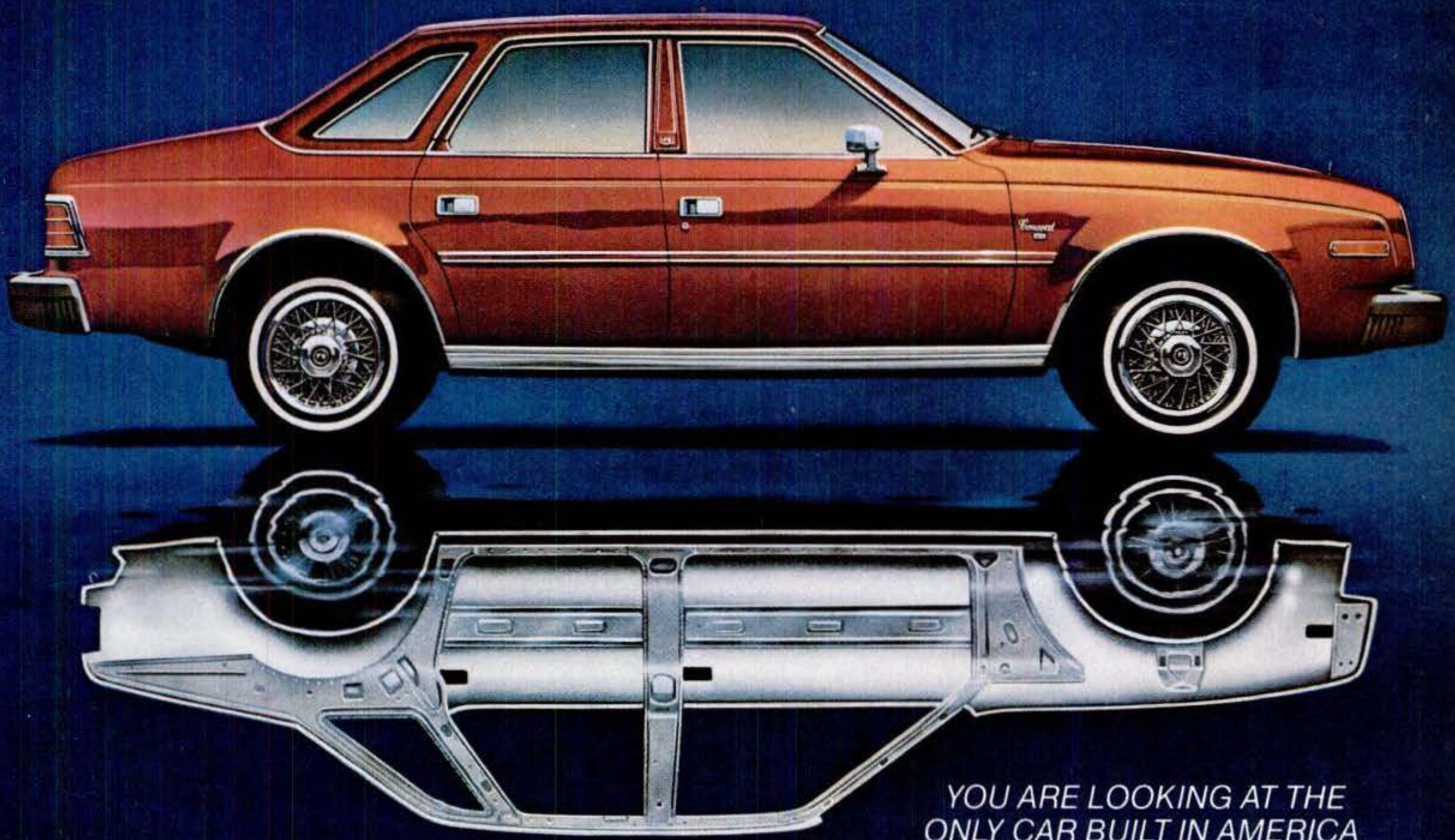
A cross section of the midprice imports (clockwise from foreground): Rover 3500, Peugeot 505, Volvo GLE, Datsun 200-SX hatchback, and Audi 5000 Turbo.

CONCORD



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*Use EPA est MPG for comparison. Your mileage may vary with speed, weather, trip length. Actual highway will probably be less. Calif. ests. may vary.

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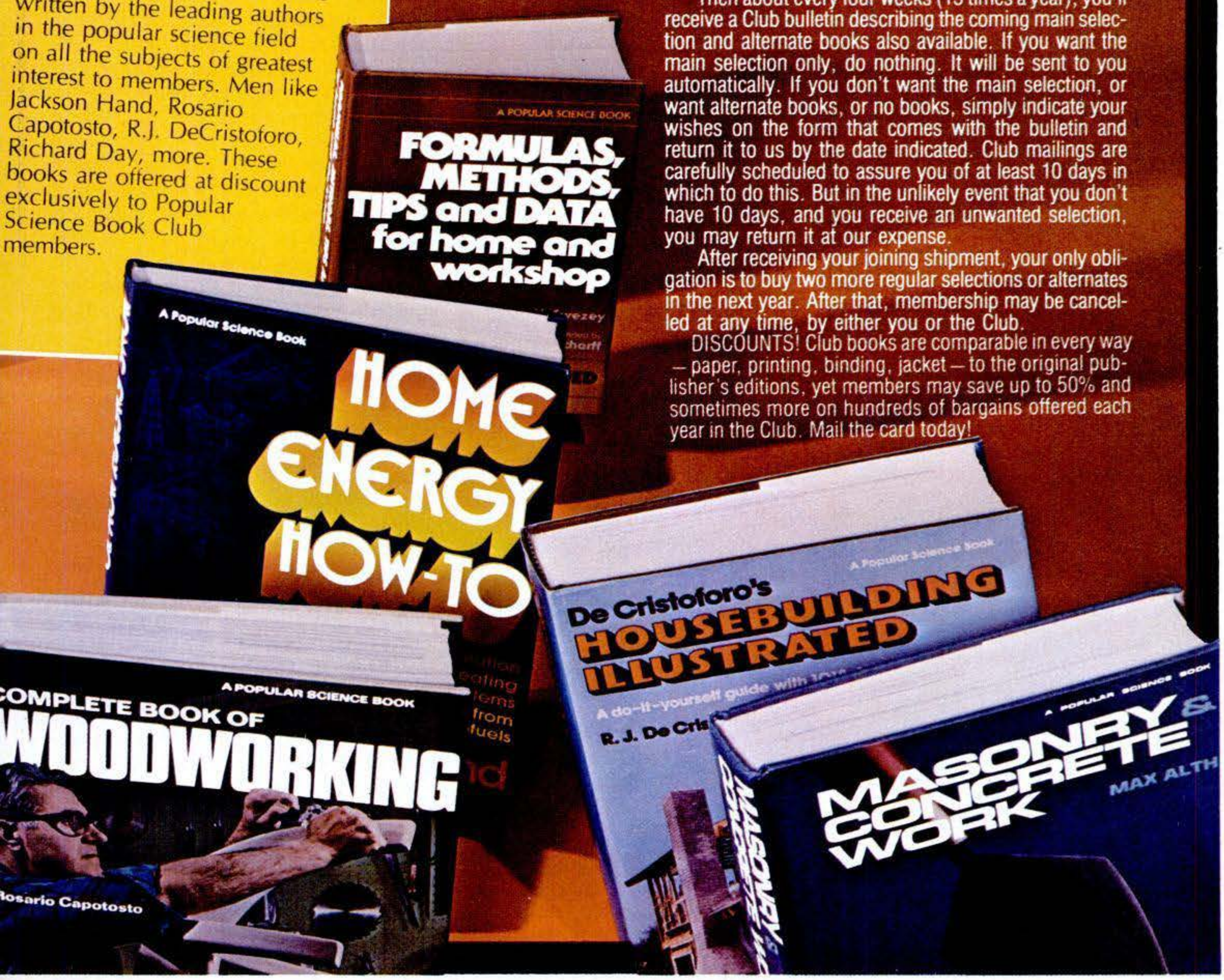

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Failure of Rover's rear brakes produced extremely long stopping distances. A chemical reaction in the brake master cylinder produced a gas in the system that caused the failure. All 3500's were recalled for master-cylinder replacement.

Peugeot's supple suspension allowed marked lean during slalom test, but did not prevent the car from easily attaining a top rating for maneuverability.

Volvo GLE. Even though the five are widely separated in price, we found great luxury in each. Not surprisingly, though, each had its own approach to performance, versatility, and economy. (Due to design peculiarities in their fuel-injection systems, we were unable to perform our normal steady-state fuel-economy tests on the Audi, Peugeot, Rover, and Volvo. We're working to avoid this in the future, and the tests will reappear next month.)

Audi 5000 Turbo

The 5000 is the latest version of Audi's premier sedan. The addition of the turbocharger to the five-cylinder engine gives midrange performance that surpasses most V8-powered cars. The power isn't neck-snapping, by any means, but there is a relentless surge while the engine is receiving maximum boost. When the turbocharger isn't producing boost, the engine performs just like the bare five-cylinder version.

Our acceleration tests reveal that the Turbo is quicker than virtually all U.S.-built, V8-powered sedans, and more than two seconds faster than its nearest competitor in this test. While the complication of the turbocharger may be a drawback to some buyers, the added performance is in keeping with the 5000's excellent ride and road manners. Unfortunately, the manual transmission that would probably make the car both better-performing and more fuel efficient is not imported.

The Audi is the only front-drive car in the group, yet you won't notice any special difference when driving it. Power steering overcomes any noticeable tendency toward front-end heaviness in turns.

The 5000's interior is luxurious yet efficient and plain. Three round dials in front of the driver house the tachometer, speedometer, odometer/trip meter, and displays for fuel level plus coolant and oil temperatures.

As in the other sedans, the seats are set high off the floor for maximum comfort. Seat backs are infinitely adjustable, and the padding is well shaped and comfortable. Driving position and visibility are both excellent. While the ride is firmer than that of the competition, it's also more controlled, and that means more comfort on long-distance rides.

Due to the front-drive layout, trunk space is large and well proportioned for a car of this size.

Continued

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How to get an unlimited number of extension phones for $89.95

The telephone can be your best friend or the most annoying invention since mothers-in-law. How many times have you made a mad dash for a ringing phone only to get there too late? How about when you're called to the phone from something you're really into only to discover it was a call that could easily have waited until later?

The Muraphone™ cordless extension phone puts an end to telephone aggravation once and for all. In fact, it makes your telephone downright fun. That's because the Muraphone goes where you go, anywhere in your home or outside it up to a whopping 400 feet. It's like having an unlimited number of extension phones. And all for only $89.95, a truly extraordinary bargain for such convenience, enjoyment and, yes, peace of mind.

The Muraphone cordless telephone system consists of a lightweight (10 Oz.) remote unit (pictured here) that clips to your belt or slips in your pocket. The remote unit operates 12 to 15 hours on a single charge of its battery. There's also a simple base unit that plugs easily into your telephone system and nearby AC electrical outlet. The system is complete; there is nothing else to buy.

Easy and fun to use.

The Muraphone is a snap to operate. A clear signal on the remote lets you know the phone is ringing. Just like a CB radio, you press the talk button to answer the phone and release the button to listen. And just like a CB you have all the fun and excitement of controlling the flow of the conversation as you actually broadcast on radio back and forth with your caller.

You can carry on a regular phone conversation with the caller. Or you can have a three way conversation with the caller and the phone at the base station. You can even use the Muraphone as a paging system and intercom between your base station phone and you.

The one thing you can't do with a Muraphone is dial out from the remote unit. But that shouldn't be a problem since answering incoming calls is by far the most important use of a cordless phone system. And it also allows us to offer the Muraphone to you at the low price of $89.95.

The Muraphone is FCC approved, UL listed, and backed by a 90 day limited warranty from Mura Corporation, a company known for its innovations in microphones, headsets, audio equipment, and telephone systems.

Try it first.

Just to prove how sure we are that you'll love your Muraphone, we're offering it to you on a 21 day trial basis. If you're not delighted, just send it back for a complete refund.

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To order with any national credit card, call the toll free number below. (In operation 7 days a week, 24 hours a day.)

If you prefer send your check including $3.50 for shipping and handling to Dimensions Unlimited at the address below.

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Datsun 200-SX

Datsun's 200-SX lineup has two all-new body styles this year: a classic notchback coupe and the rakish hatchback we selected. The major advantage of the hatchback design is evident from the 25.2-cu.-ft. cargo rating of this relatively small car. That's around twice the trunk capacity of the bigger, costlier European sedans (though well short of the hatchback Rover's capacity) and almost three times the space of the notchback 200-SX. The load compartment easily converts from passenger mode to cargo. And the rear seats are split so one can remain upright while the other is folded down.

Driving position is excellent and visibility is very good, but the SX is no miracle car when interior room is measured. While there's plenty of room up front, rear-seat room is inadequate. Head room and leg room are okay for children, but not for adults. If you must regularly carry adults, check out the notchback's rear-seat room.

Aside from the sporty styling and a host of other comfort and convenience features, fuel economy is the SX's biggest selling point. Our steady-state cruise tests produced an impressive 49.6 mpg at 35 mph, and 36.3 at 55 mph.

From a driver's perspective, perhaps the nicest feature is the outstanding instrument array. It is not only comprehensive, well laid out, and easy to understand, but it's also the best analog instrument panel we've ever seen for night driving—easily the equal of the fine digital panels from Ford and Chrysler. Where other analog panels have soft light shining onto the gauge faces, the Datsun's has the light shining through them. So the numbers and indicator needles actually light up, as brilliantly as you choose. The effect is impressive.

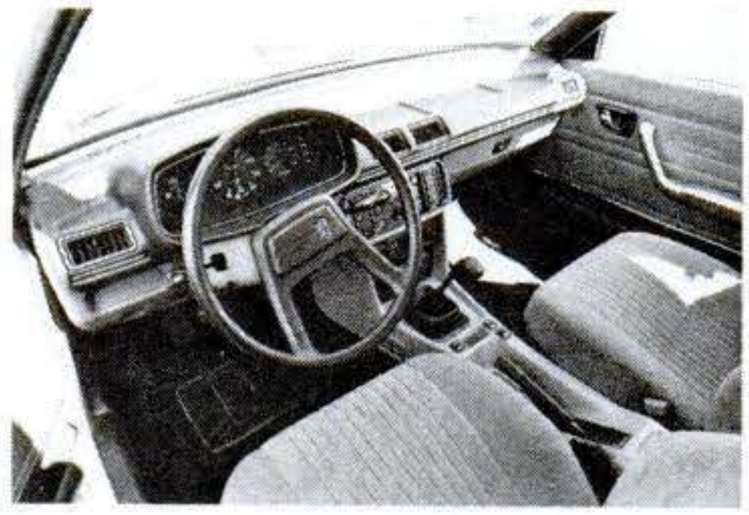
The sporty 200-SX embodies many of the detail features that make Japanese cars pleasing to American buyers: Tiny motors adjust the two outside mirrors. A single lever balances the four stereo speakers. And a spotlight and two reading lights are mounted in the headliner above the front-seat passengers. And, as we've come to expect from Japanese cars, the fit and finish were first class throughout.

EPA fuel mileage (mpg)

	Audi 5000 Turbo	Datsun 200-SX	Peugeot 505	Rover 3500	Volvo GLE
Highway	25	40	24	25	27
City	18	28	16	15	16
Calif. city	18	27	16	14	16

Volvo's rear compartment is spacious and comfortable. Plush headrest pads are removable (as behind author Dunne's head) for better rear visibility.

Informative modular instrument panel sits atop Rover's dash, which also has scooped-out area to hold coins, receipts, and other small items.



Peugeot's conventional instrumentation is centrally located, easy to read, and not at all obscured by the downswept spokes of the steering wheel.

Peugeot 505

Peugeot's 505 sedan looks, feels, rides more luxuriously than the 504 it replaces. Many of the problems American buyers found in the 504 have been smoothed over. And Peugeot's traditionally serene ride, precise handling, and extraordinary seating comfort are as strong as ever.

You won't get outstanding performance in any Peugeot, but the 505's fuel-injection system does improve acceleration to an acceptable level. It helps the new two-liter, four-cylinder engine provide smooth operation at all speeds, and eliminates cold-start misfiring.

The five-speed manual transmission is needed to get maximum performance from the engine, but a distinct side pressure on the shifter is needed to properly shift from first gear into second. While you would expect higher economy ratings from a manual transmission than from an automatic, the five-speed has been coupled to a more aggressive final-drive ratio, so it only ties the automatic's EPA highway rating of 24 mpg, and falls three mpg short in the city (16 vs. 19). One reason for the 505's EPA ratings being relatively low is that Peugeot has chosen to meet the stricter, economy-cutting 1981 emissions standards a year early.

In addition to outstanding seating comfort, excellent driving position, and very good visibility, the 505 offers as wide a selection of conveniences as the others. Among its peculiarities are turn signals that flash both dashboard indicator arrows together, and the lack of an engine-saving rpm limit (redline) on the tachometer.

Acceleration may be slow, but the

Continued

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Make damn sure you're serious.

Before you even consider buying a Jeep Cherokee, make sure you're serious. Because there are plenty of choices out there, including Broncos and Blazers. But only one is born of the rugged Jeep legend. And we consider Cherokee the best sports utility vehicle available in America today.

That's a pretty big statement for *any* vehicle to back up. But Cherokee doesn't back away from a little healthy competition.

Its 4-wheel drive system is built in from the ground up, not added on. It has an integral steel roof, not plastic. It comes in 2-door *and* 4-door models, unlike its biggest competitors. And 96% of all Jeep vehicles registered in the last 10 years are still in operation today†. Nobody can match that record.

A serious off-roader is more interested in what a vehicle can do once its wheels start rolling. Here's how Pickup, Van & 4WD experienced Cherokee's performance; "Climbed at little more than an idle. Although deeply rutted...the hill was no problem."

Cherokee's ride: "Exceptionally comfortable...its wide radials and anti-roll bar certainly contributed."

JEEP CHEROKEE 4-DOOR MODEL

Chereokee's handling: "Behaved more like a sports car than a sports utility. In one package...good looks, great performance, super fuel mileage* and excellent quality control."

Remember, we didn't say it, *they* did. But if you're as serious about 4-wheel trucking as we are, you owe it to yourself to get behind the wheel of a genuine Jeep Cherokee. Then make your decision.

16 EPA EST. MPG* 21 HWY EST.

Jeep Cherokee. The Truck.

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†96%—Based on R.L. Polk & Co. registrations through July 1, 1979.

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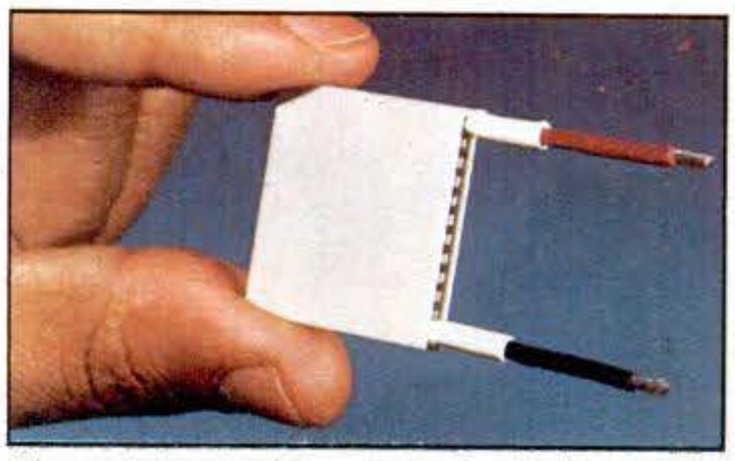
You've nicely gotten away on your long awaited vacation, camping trip or long weekend with the family. You're comfortably cruising in your car, van or rec. vehicle along a busy interstate with few rest stops or restaurants. You guessed it...the kids want to stop for a snack. But your Koolatron P34 or P34A is full of sandwiches, cold pop, fried chicken...home made, fresh and cold. The family helps themselves and you've saved valuable vacation time and another expensive restaurant bill.

You're a commuter, a salesman or a trucker and you spend many hours in your vehicle daily. You've often longed for a fresh snack or cold beverage as the miles tick away. Now with your amazing Koolatron P10 plugged in beside you, you open the lid and instantly fresh food and drinks are at your fingertips. You're refreshed...you've saved an unnecessary stop, time and money.

AFFORDABLE CONVENIENCE

Home refrigeration has come a long way since the days of the ice box and the block of ice. But most of us resign ourselves to doing without the same convenience once we leave our homes. Or, we revert back to the cooler and ice routine of days gone by, simply because there's never been any dependable and inexpensive alternative. But now, for the price of a good cooler and one or two seasons of buying ice, (or about 10 family restaurant meals), all the marvels of home refrigeration are available electronically. And the sloppy ice cooler with its soggy and spoiled food can become a stone-age memory for you. An amazing space-age miracle...the thermoelectric solid state module...makes this portable refrigeration revolution possible.

AEROSPACE MODULES



These miniaturized thermoelectric modules replace all the bulky complex piping coils, compressors and motors in conventional portable refrigerators.

Utilized by NASA scientists, as the only refrigeration system for rockets and satellites, thermo-electric cooling has been in use for almost a quarter century. These expensive modules were selected by NASA for some basic reasons...they're small (about the size of your watch)...they're light weight (they weigh less than a package of cigarettes)... they're totally reliable (these modules are completely solid state and have no moving parts)...they require little power (they use the same power as one of your car's tail-lights)...they're completely insensitive to tilting, bumping, vibration, (which causes failures to conventional compressors, motors and piping)...they're powerful (these modules have the same cooling power as a 10 lb. block of ice)...and they never wear out or break down. And for portable refrigeration where you require 12 volt DC. power, thermo-electric modules are the most efficient. These amazing heat pumps have not only gone to the moon, but have provided the breakthrough for Koolatron's truly reliable, lightweight portable refrigerators.

THOUSANDS IN USE

Koolatron Industries Limited now has tens of thousands of these electronic fridges in use worldwide using these same powerful solid state modules. The reliability, performance and convenience of electronic refrigeration has now been dramatically tested and proven in all kinds of temperatures, conditions and environments from Australia to Alaska. Built to take it, these electronic modules are encased in tough, plastic insulated chests that are designed to be rugged and trouble-free. Non-rusting hinges and latches prevent corrosion in salt water environments. And with only one moving part (a small 12 volt fan) Koolatron portables seldom see a service depot. Koolatron's combination of space-age heat pumps and quality engineering have now led to a whole family of electronic portable refrigerators and food warmers that eliminate costly ice and provide "home refrigeration" convenience at sane and sensible prices.

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MODEL P10-
THE PERFECT CAR FRIDGE
& FOOD WARMER

~~$129.~~ **$99.00**
(in Canada ~~$139.~~ $109.00)

Holds approx. 17, 12 oz. pop cans–refrigerates in air temps. up to 95°F. Also keeps hot foods hot (150°F.) at the flick of a switch. Tough, blue Polypro plastic case. Ext. 16"L x 11"H x 11-1/2" W. Int. 11-1/2"L x 8"H x 8"W. with 10 litre capacity (0.4 cu. ft.) weighs 10 lbs. empty. Operates from supplied 12 volt power cord in vehicles or with optional 12VDC/110VAC power adaptor.

Koolatron's P10 not only makes a great car fridge but at a flick of a switch lets you bring home your favourite fast foods "piping hot". Comes with a 9 ft. power cord that just plugs into your cigarette lighter. Amazingly easy to operate...one switch selects hot or cold. A second switch allows you to refrigerate normally or select maximum cold. With your engine off, you can operate several hours and still start your engine to recharge your battery. "A low battery" indicator warns you when it's time to recharge. With the power off, your P10 keeps everything hot or cold for many hours in its well insulated case.

As a travel fridge the P10 keeps your favourite foods and beverages fresh and cold wherever you go. If you're a salesman, your food samples will arrive perfectly hot or cold every time. If you carry insulin, medical samples, dietetic foods, your P10 will never leave your side. Great for private planes.

Photographers will find it invaluable for keeping expensive films from going bad. And mothers...now you can refrigerate baby's formula in your car then heat it with the flick of a switch. Powerboaters, just plug it into your boat's cigarette lighter, and keep a day's food and drink ice cold without running into shore for ice. You campers, hunters and fishermen will find endless uses for transporting provisions and bait...then take home your catches and game without spoiling. Terrific for golf carts.

And with our optional 110 volt adaptor you'll find endless uses wherever house current is available...At your cottage... as a bar fridge...in your motel room for a midnight snack and drink or as a small office fridge. Use as an auxiliary home fridge when you're having a party. And it's a natural at drive-in movies, auto races and at sporting events.

MODEL P34-
THE STANDARD
RECREATIONAL FRIDGE

~~$169.~~ **$139.00**
(in Canada ~~$179.~~ $149.00)

Holds over 40 lbs. of food and beverages or 48 pop cans. Refrigerates in air temperatures up to 95°F. Rugged ABS case in sand beige colour with dark brown non-corroding latches and handle. Large 34 litre capacity (1.2 cu. ft.) weighs 17 lbs. empty. Ext. 21"L x 16"H x 16"W. Int. 16"L x 12"H x 11-1/2"W. Operates on 12 volts DC with supplied power cord or with optional 12VDC/110VAC power adaptor.

The P34 is our standard recreational size portable refrigerator. This new, improved model has a non-adjustable solid state thermostat which keeps your food at normal refrigeration temperature even in 95°F weather. It holds more than three times as much as the P10.

Imagine dry, dependable refrigeration with the size to match your travelling and camping needs. Fits into any boat, van or camper or back seat of your car. Plugs into your cigarette lighter receptacle and refrigerates over 40 lbs. of food (no space wasted by ice), yet it draws no more power than the P10. With our optional 110 volt adaptor, you'll find endless uses as a bar fridge, cottage fridge, office fridge. Your P34 has all the advantages of the P10 without the heating cycle or low battery indicator but with all the capacity needed for serious boaters, campers, hunters, fishermen and travellers.

MODEL P34A-
THE DELUXE RECREATIONAL
REFRIGERATOR &
FOOD WARMER

~~$189.~~ **$159.00**
(in Canada ~~$199.~~ $169.00)

The same size, colour, weight and capacity as the P34 but includes food warming features, fully adjustable temperature control and low battery warning indicator.

The P34A is our top of the line portable. It heats, it refrigerates and with specially designed electronic circuit control (patent pending) it allows you to dial a complete range of temperatures from very cold to very warm.

Imagine the versatility. In season, refrigerate all your hunting, camping, boating and cottage provisions. Off-season, keep foods piping hot on your ice-fishing, skiing and snowmobiling weekends. You can even dial wine-cooling temperatures. Our low battery indicator warns you when you need a recharge and the sensing circuits efficiently control your power consumption to save on battery drain. This is our best of the line, recreational fridge and food warmer with all the bells and whistles for the discerning buyer who demands quality, size and complete versatility.

READ WHAT OUR CUSTOMERS SAY:

"We took meat from Canada and ate it ten days later after thawing it in Florida. All our produce and drinks stayed unbelievably fresh and cool." S.H., Hamilton, Canada

"The way I try to sell my refrigerator one would think I was on commission. We love our unit!" P.O.P., Houston, Texas

"The Koolatron is everything they say about it in its advertising. I personally bought one, tested it and found it so desirable that I gave it to my daughter and son-in-law who made a cross-country trek from Vermont to Oregon with their infant daughter. They told me that aside from their new Dodge van, the Koolatron was the most indispensable item of equipment they carried." K.M., New York, N.Y.

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By ordering off-season you can save a full $30 off our regular prices. You save! We keep our plant operating at an efficient level.

ORDER TODAY WITHOUT OBLIGATION!

Simply complete the attached order form or phone collect and we'll rush you your portable on our no risk 21 day trial offer. Each unit comes with complete instructions and a written 1 year warranty. In the unlikely event you ever need service, we have major service centres in New York, Arizona and Canada.

When you receive your Koolatron, use it constantly for 3 full weeks without risk. If you ordered our optional 110 volt adaptor, plug it in, then use your portable immediately as a bar fridge or around the patio or pool. Next plug it into your car or RV. Take your family out for a weekend trip. Enjoy fresh home cooked food as you thumb your nose at those expensive restaurant stops. Then use it on your boat or in your office or let your son or daughter try it at their college dorm. If after you've thoroughly tested it, you don't agree that your Koolatron represents a major breakthrough that will save you time, money and bother for years to come, send it back for a full refund. You can't lose...we guarantee it.

So be among the thousands to discover that the ice age is over! Don't waste another dollar on ice...order your Koolatron with no obligation, today!

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Or use this handy order coupon.

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Industries Limited
56 Harvester Avenue, Batavia, New York 14020
Canada: 230 Bayview Drive, Barrie, Ontario L4N 4Y8

Save me $30 with these off-season prices:

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____Koolatron P34 at $139.00 ($149.00 in Canada)

____Koolatron P34A at $159.00 ($169.00 in Canada)

____Koolatron 110V adaptor at $29.95 ($34.95 in Canada)

Please add $8.00 for handling and delivery per unit.
No charge for shipping adaptor if ordered with unit.
Add $3.00 for shipping adaptor only.
(N.Y., Ont. and Quebec residents add sales tax.)

I understand that I may return any item undamaged by January 15, 1981 or a minimum of 21 days, and receive a full refund if I am not satisfied.

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ride and road manners are outstanding. If you haven't driven a European car for some time, you'll also be impressed with the Peugeot's improvement in air conditioning, power windows, and noise reduction. They're typical of the catching up Europe has done with America.

Rover 3500

The Rover 3500 is a V8-powered, British-built fastback, and its design makes it almost unique among mid-price luxury import sedans. The hatchback arrangement offers a well-proportioned 34-cu.-ft. cargo space when the rear seat is folded down—nearly large enough to be classified as a station wagon by the EPA. But there's very comfortable seating for three when it's upright.

The front seats provide exceptional comfort. The cushions are thick, but on the firm side, with body-hugging contours. Driving position is very good, and visibility is excellent.

Most interesting of the Rover's mechanical systems is the 3.5-liter (215 cu. in.) aluminum V8 engine, developed by GM in the 1960's and then abandoned as being too small. The design was sold to Rover and became one of the firm's basic power plants, as well as being used in the English-built Morgan + 8 and Triumph TR8 (in next month's car test).

Performance is sprightly, though a long way from that of the fire-breathing sporty cars of a few years ago. Acceleration is exceptionally smooth and quiet. Add quick steering—2.75 turns lock to lock—and an easy-handling sporty suspension and you get a fine driving package well suited to the family-car buyer who wants some gusto.

Despite the pleasing performance and comfort, we did find some problems. No matter how it is positioned, the adjustable steering wheel, and/or your right hand, obstructs the view of major instruments, negating the value of the elaborate instrument panel. In addition, on hard acceleration, rear-axle windup produces a loud thump that's completely out of place.

Another major problem was the almost complete unraveling of the accelerator cable at the foot pedal. Our test car had only 5000 miles on the odometer, and only two strands remained intact. Had the cable broken at full power, the snapped strands might conceivably have locked the accelerator at full throttle.

Finally, we experienced rear-brake failure during our regular brake tests.

Emergency response and handling are checked in high-speed lane-change. Here, Datsun veers sharply right and nose comes up in response to full throttle.

That limited braking force to the front wheels, and caused exceptionally long stopping distances. Jaguar Rover Triumph subsequently recalled all 3500's to replace defective brake master cylinders. (Note that the front brakes were not affected by the failure.)

Volvo GLE

If you haven't driven a Volvo for a few years, you're in for a surprise. The old, rigid feel has been replaced by a supple suspension that makes a better-handling car and offers a definite improvement in the ride.

Volvo's traditional emphasis on passenger comfort is even greater in the GLE. Slim doors reach high up in the car body to aid your entry and exit. Thickly cushioned seats deliver top-rate comfort for long-distance driving. Backrests are infinitely variable and also have adjustable lumbar support. The driving position is an excellent, heads-up, arms-out type, and visibility all around is very good.

The GLE's excellent instrument panel appears more technical than pretty, and that's the way we like it. Important gauges are large and legible, and placed directly in front of the driver, unobstructed by the rim of the steering wheel. Controls and switches are highly visible and within easy reach. Only the radio controls, placed down near the top of the transmission tunnel, require stretching.

The rear seats are the most comfortable in the group. Rear-seat room is excellent for two passengers, and at least adequate for three. Leg and foot room are both very good. Shoulder harnesses (as in the Peugeot) and cushioned, removable head restraints are provided for the two outboard rear-seat passengers.

A four-speed manual transmission with an electrically operated overdrive is virtually unknown on this side of the Atlantic, but the engagement is gentle enough if you simultaneously depress the clutch, as Volvo recommends.

The GLE's V6 engine is very smooth running—almost equal to a V8—and its performance needs no excuses. While fuel economy has never been terrific with the big Volvos, the GLE is no worse than other imports in its class. In fact, in some respects it's even better, and is comparable to V8-equipped, full-size American cars.

Our picks

The Audi's turbocharger makes the 5000 the equal of any U.S.-built luxury sedan, regardless of price. Still, it's tough to swallow its high price and cost of service. At the same time, the 200-SX is a recommended buy for shoppers looking for a sporty compact car.—J.D.

The Audi has the responsive power; the Peugeot and Volvo, maximum comfort; and the Rover, spirited driving with greater versatility. But, on balance, I'd pick the 200-SX. It combines much of the best of the Europeans, adds some fine points of its own, and delivers superior fuel economy for thousands of dollars less.—E. J.

For specs and test results, see page 50

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QUALITY IN EVERY EXTRA MILE

Someone's always home when the Night Sentry Timer is on duty.

Night Sentry puts electronic timed lighting control where it belongs: on the wall...

Most home security experts agree that one of the most effective deterrents to intruders and burglars is lighting that creates the "lived-in" look while you're away. Now the new Dynascan Night Sentry enables you to easily achieve that lived-in look. Using a micro-computer that does the work of more than 10,000 transistors, it provides automatic control of indoor or outdoor light fixtures, including porch, post, kitchen, bathroom, and bedroom lights.

The amazing micro-computer's "memory" permits automatic self-programming (just use the Night Sentry as a conventional light-switch—after 24 hours, your pattern of light use will be repeated daily thereafter.) You also can program it manually in a matter of seconds! Up to 48 ON-OFF settings per 24-hour period are possible. Installs in minutes with only a screwdriver.

Comparison Chart

FEATURE	NIGHT SENTRY	OTHER TIMERS
1. Automatic programming	**YES**	NO
2. Manual programming	**YES**	YES
3. Built-in microprocessor/memory	**YES**	NO
4. Solid-state reliability	**YES**	NO
5. Silent operation (no motor)	**YES**	NO
6. 48 "ON-OFF" selections	**YES**	SOME MODELS
7. Variable "ON-OFF" times	**YES**	SOME MODELS
8. Easy pushbutton override	**YES**	NO
9. Easy 2-wire installation	**YES**	NO
10. Fits any single or multiple switch box	**YES**	NO
11. Usable with most standard or decorator switch plates	**YES**	NO
12. Attractive "low-profile" decorator styling	**YES**	NO
13. "Soft-start" triples bulb life	**YES**	NO
14. Available in 3-way model	**YES**	NO
15. Available in table model with dimmer	**YES**	NO

Check these "never-before-available" features: No clock motor or gears to become noisy; easy override of program to use as conventional ON-OFF switch (no fumbling behind or under furniture to locate an override button); built-in variability of ON-OFF times to confuse intruders or burglars "casing" your home; usable in single or gang switch boxes; uses existing standard or decorator switch plates; available in 3-way version. Also available: table top model for controlling lamps plugged into wall outlets.

Visit your local hardware, home center, or department store and see the new Night Sentry. Suggested retail price under $25.

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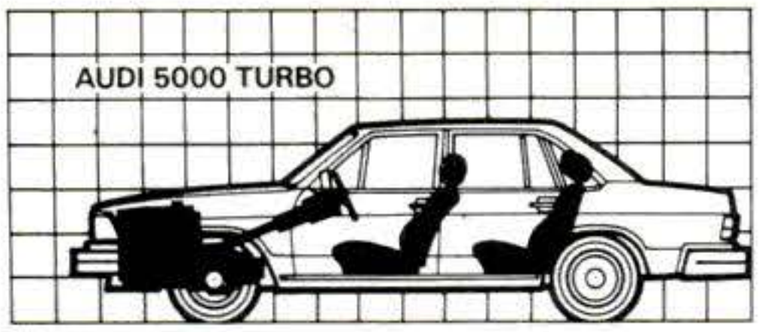

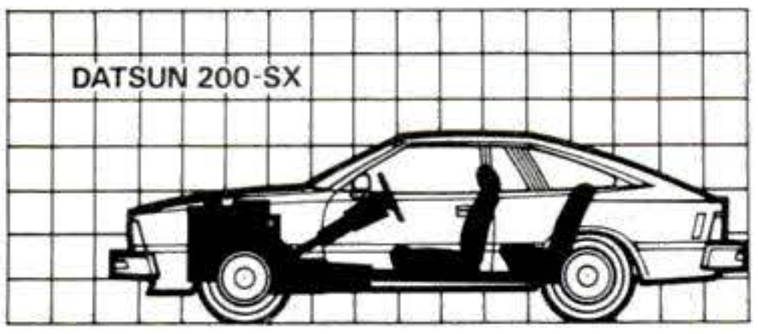

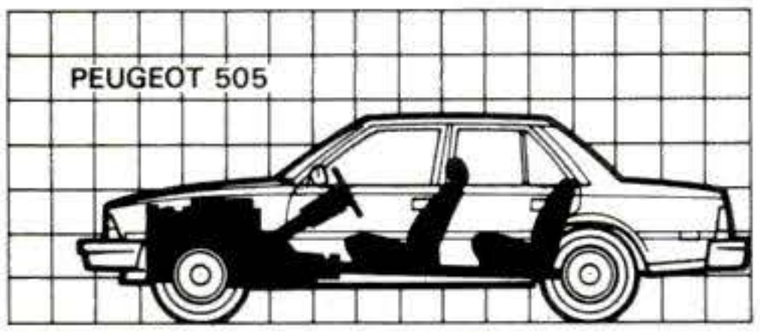

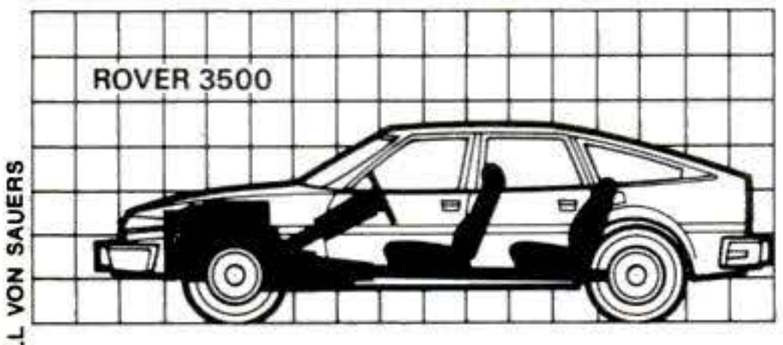

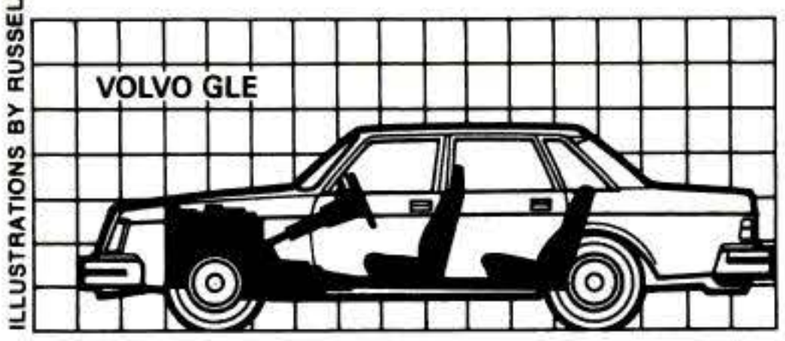

ILLUSTRATIONS BY RUSSELL VON SAUERS

Audi 5000 Turbo, Datsun 200-SX, Peugeot 505, Rover 3500, and Volvo GLE —dimensions, specs, and test results

	Audi 5000 Turbo	Datsun 200-SX	Peugeot 505	Rover 3500	Volvo GLE
DIMENSIONS (inches)					
Wheelbase	105.5	94.5	107.9	110.8	104.3
Overall length	188.9	176.4	186.6	185.0	192.5
Overall height	54.7	51.6	56.6	54.4	56.3
Overall width	69.6	66.1	66.3	69.6	67.3
Track, F/R	58.1/57.2	53.0/53.0	56.4/56.8	59.1/59.1	56.3/53.5
Ground clearance	4.4	6.7	8.0	8.8	4.7
Front head room	36.0	33.0	34.0	34.0	36.0
Front hip room	44.0	42.0	38.0	44.0	42.0
Front leg room	44.0	44.0	44.0	42.0	44.0
Rear head room	34.0	33.0	33.0	36.0	32.0
Rear hip room	56.0	48.0	52.0	54.0	56.0
Rear leg room (min.)	36.0	26.0	36.0	36.0	36.0
Rear knee room (min.)	1.0	3.0	3.0	5.0	4.0
Couple distance	36.0	32.0	33.0	34.0	38.0
SPECIFICATIONS					
Engine type	I5	I4	I4	V8	V6
Displacement (cu. in./L)	131/2.1	120/2.0	120/2.0	215/3.5	175/2.8
Compression ratio	7.0:1	8.5:1	8.35:1	8.15:1	8.8:1
Carburetion	F.I.	F.I.	F.I.	F.I.	F.I.
Net hp @ rpm	130 @ 5400	100 @ 5200	96 @ 4900	148 @ 5100	130 @ 5500
Net torque @ rpm	142 @ 3000	112 @ 3200	116 @ 3300	180 @ 3250	153 @ 2750
Transmission	Three-speed automatic	Five-speed manual	Five-speed manual	Five-speed manual	Four-speed manual + O.D.
Axle ratio	3.73:1	3.70:1	4.11:1	3.08:1	3.73:1
Tire make	Fulda	Bridgestone	Michelin	Michelin	Michelin
Tire type	Y2000 radial	RD-113 Steel Wide 70	XVS steel-belted radial	XVS steel-belted radial	ZX steel-belted radial
Tire size	60HR14	185/70SR14	175HR14	70HR14	70SR14
Steering	Rack and pinion, power	Recirculating ball, power	Rack and pinion, power	Rack and pinion, power	Rack and pinion, power
Overall steering ratio	18.4:1	Variable 18.0–20.5:1	17.0:1	n.a.	17.3:1
Turns, lock to lock	3.76	n.a.	3.5	2.75	3.5
Turn diameter (ft.)	34.7	34.0	37.0	34.3	32.0
Front suspension	Independent, MacPherson struts	Independent, MacPherson struts	Independent, MacPherson struts	Independent, MacPherson struts	Independent, MacPherson struts
Rear suspension	Torsion-crank axle, panhard rod, coil springs	Rigid axle, coil springs	Independent, trailing arms, coil springs	Rigid axle, Watts linkage, coil springs	Rigid axle, four trailing links, panhard rod, coil springs
Front stabilizer-bar diameter (in.)	0.90	0.75	0.85	0.75	0.75
Rear stabilizer-bar diameter (in.)	0.94	none	0.63	0.75	0.62
Trailer towing (max. lbs.)	Not recommended	2000	2866	3360	2000
Trailer tongue weight (max. lbs.)	Not recommended	110	176	350	200
Brakes	Disc/disc, power	Disc/disc, power	Disc/disc, power	Disc/drum, power	Disc/disc, power
Brake swept area (sq. in.)	n.a.	273.0	434.0	349.0	398.0
Fuel tank (gal.)	19.8	15.9	18.0	17.4	15.8
Trunk space (cu. ft.)	15.0	9.6/25.2*	13.8	34.0*	13.9
Liftover height (in.)	n.a.	n.a.	30.75	34.0	30.7
Curb weight (lbs.)	3042	2637	3075	3226	3149
F/R weight distribution (%)	n.a.	56/44	54/46	56/44	52/48
Basic price	$16,480	$6889	$10,400	$15,900	$13,710
Price as tested	$16,865	$8369	$12,650	$16,135	$15,411
Major options on test car	Power mirrors $120, metallic paint $265	Sports-luxury package $900, A/C $580	S package $2250	Sunroof $235	Special Edition package $1300, CB radio $300
TEST RESULTS					
Acceleration (sec.)					
0-60 mph	11.2	14.8	17.3	13.5	13.5
25-70 mph	12.0	16.9	21.1	14.5	15.0
Brake test (cool) 60-0 mph					
Stopping distance (ft.)	207	181	179	285	176
Pedal pressure (lbs.)	200	65	138	135	110
Brake test (hot) 60-0 mph					
Stopping distance (ft.)	204	184	187	265	160
Pedal pressure (lbs.)	200	100	131	125	158
Interior noise @ 60 mph (dBA)	73	73	71	73	69
Handling test (mph)	58.2	61.0	59.3	61.0	59.0
Maneuverability test (mph)†	27.6+	27.6+	27.6+	27.6+	27.6+

TEST CONDITIONS: Ambient temperature, 85° F; relative humidity, 75 percent; barometric pressure, 30.1 inches Hg

*With rear seat folded

†Maneuverability-test results given as 27.6+ indicate that the car exceeded our minimum for a "5" rating in the slalom. Testing at higher speeds was not performed.

PS serviceability ratings

How easy is it to service these cars? To give you an approximation of how difficult it is for a typical person to perform various service operations, we examine each test vehicle. The numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty; 4, easy; 5, very easy.

	Audi 5000 Turbo	Datsun 200-SX	Peugeot 505	Rover 3500	Volvo GLE
Checking fluid levels					
Battery	2	5	4	5	5
Master cylinder	5	5	5	5	5
Windshield washer	5	5	5	5	5
Engine oil	4	4	3	3	5
Coolant	5	5	3	3	5
Checking the engine					
Spark plugs	5	4	3	3	1
Distributor	4	4	3	4	1
Carb adjustment	F.I.	F.I.	F.I.	F.I.	F.I.
Oil filter	3	2	3	3	1
Oil fill	4	4	3	3	2
Replacing hoses					
Upper radiator hose	3	3	5	4	3
Lower radiator hose	4	1	4	3	2
Heater hose	2	3	2	2	2
Changing bulbs					
Headlights	3	3	3	3	3
Taillights	4	4	3	3	3
Front running lights	3	3	3	3	3
Front parking lights	3	3	3	3	3
Front directionals	3	3	4	3	3
Rear directionals	4	4	3	3	3
Rear running lights	4	4	3	3	3
Checking fuses	4	4	3	4	4
Spare-tire accessibility	3	4	3	3	4
Changing belts	3	2	3	3	1

Performance comparison with selected 1980 and earlier models

	Mpg (city driving)	Acceleration 0–60 mph (sec.)	Brakes 60–0 mph (hot) (ft.)	Handling (mph)	Maneuverability (mph)	Noise @ 60 mph (dBA)
1980 Mercedes-Benz 300SD I5	24	13.6	179	62.4	28.1	71
1979 Saab 900 Turbo I4	19	11.4	129	64.7	28.1	73
1979 Toyota Celica Supra I6	19	12.3	153	62.4	29.1	68
1979 Datsun 810 I6	21	11.3	198	62.4	26.6	73
1978 BMW 320i I4	19	12.2	140	64.7	29.6	74
1978 Peugeot 604 V6	15	13.7	166	64.7	28.6	71
1978 Audi 5000 I5	17	14.4	143	62.4	28.1	73

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Double-duty heat pump

stores chemical heat, too

"Chemical sponge" collects solar energy to power a heat pump

By DAVID SCOTT
ILLUSTRATION BY RAY PIOCH

If you could store summer's abundant solar energy for winter use, rooftop collectors could supply a family's year-round heating needs.

That dream of free energy was the starting point for Professor Ernst-Ake Brunberg, a physicist at Sweden's Royal Institute of Technology in Stockholm. Though practical long-term energy storage has stumped scientists for years, Brunberg thinks he has the answer: a chemical heat pump.

Like a heat pump, Brunberg's Tepidus system transfers heat (against the laws of thermodynamics) "uphill" from a cool place to a warm one. Unlike a heat pump, Tepidus doubles the energy extracted from the cool place, augmenting it with a chemical reaction that generates its own heat. And, unlike other types of chemical heat pumps [PS, Oct. '78], Tepidus can store energy indefinitely.

Since last November, the Tepidus system has been on trial in a five-room house near Stockholm with 100 square meters of floor space. Eight giant salt tanks, called accumulators, are crammed into one end of the basement. They're fed from 40 square meters of solar collector panels, which should provide for a whole year's heating needs. There is no other energy source, so no fuel bills.

A real breakthrough? Brunberg claims a good deal for the system. It has a remarkable energy-conversion efficiency of 95 percent, he says, and very high energy density compared to other storage media such as water, rocks, or phase-change salts. Brunberg also claims low losses for the system, which has few critical moving parts. And sodium sulfide (NaS_2), the chemical used, is cheap and needs neither replacement nor attention once installed.

This simple salt is key to the system's energy-storage cycle. Sodium

Continued

Touch-testing salt tank, Professor Ernst-Åke Brunberg checks temperature before sealing. Insulation serves merely to retain sensible heat for immediate domestic use. When sealed, a tankful of fully dried, energy-charged salts loses only five percent of its potential energy content—even when it cools to room temperature. This means that charged salt tanks can be transported and stored indefinitely until heat is needed.

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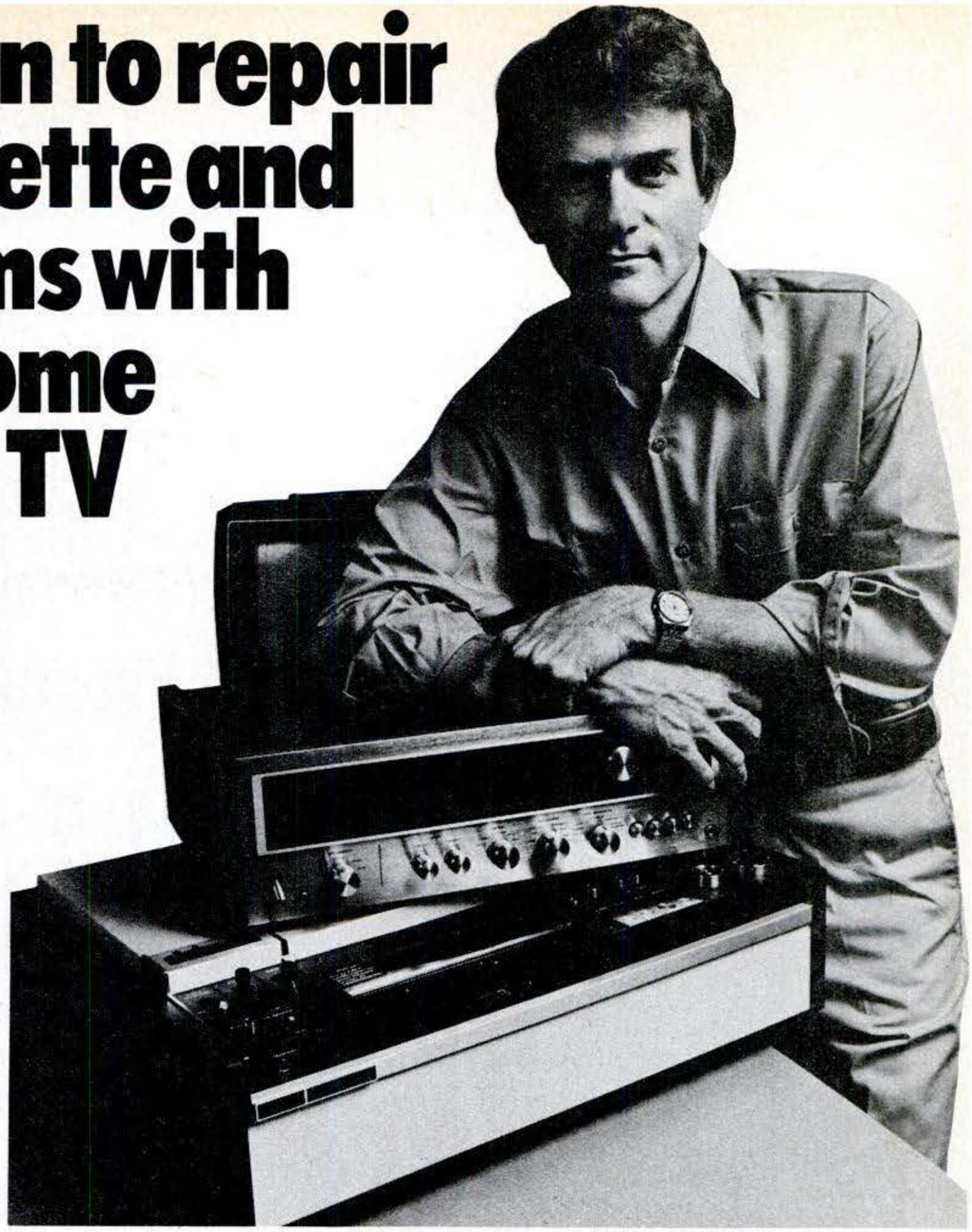

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You learn right at home, at your convenience, without quitting your job or going to night school. NRI "bite-size" lessons make learning easier...NRI "hands-on" training gives you practical bench experience as you progress. You not only get theory, you actually build and test electronic circuits, a complete audio system, even a color TV.

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As part of your training in NRI's Master Course, you assemble and keep NRI's exclusive, designed-for-learning 25" (diagonal) color TV, the only one complete with built-in computer tuning that lets you program an entire evening's entertainment. As you build it, you introduce and correct electronic faults, gain understanding and practical experience.

You also construct a solid-state stereo amplifier and tuner, complete with speakers. You even assemble professional test instruments, so you know what makes them tick, too. You build a transistorized volt-ohm meter ...a CMOS digital frequency counter... integrated circuit TV pattern generator ...even a solid-state triggered-sweep 5" oscilloscope. You use them in your course, keep them for actual TV and audio servicing work.

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Send today for the 100-page catalog that shows all the lessons, all the equipment and training material you get. The catalog will show you other NRI opportunity fields like the new course in Microcomputers & Microprocessors, Complete Communications, and more. With the addition of video cassette and disc systems, television has taken on an exciting new dimension. NRI training can put you right in the center of that dimension.

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Dodge ARIES K

Dodge Aries-K is the first automobile to deliver both 6-passenger room and gas mileage ratings of 25 EPA est. mpg./41 est. Hwy.* A combination that no other car can match. How did Chrysler do it? With advanced front-wheel-drive technology. Solidly based on over 11 billion estimated miles of owner experience with Chrysler Corporation's highly successful small cars, including Dodge Omni, Dodge 024 and Colt. More small-car front-wheel-drive experience in America than Datsun, Toyota, GM or Ford. With all that experience, Chrysler engineers designed Aries-K as a total system—a *Direct Power System* of front-wheel-drive that puts the weight of the engine and transaxle directly over the front driving wheels. This gives you excellent traction in rain and snow. The car is *pulled* through turns, rather than pushed. So you get sure control and maneuverability. And with the engine, transaxle and entire power-train in front of the passenger compartment, Aries-K offers mid-size room—6-passenger room—in a neat, efficient package. And without a transmission, drive shaft and rear-axle differential churning away underneath the Aries-K, you'll enjoy a smooth, quiet ride. And an efficient use of energy.

1128496374 2

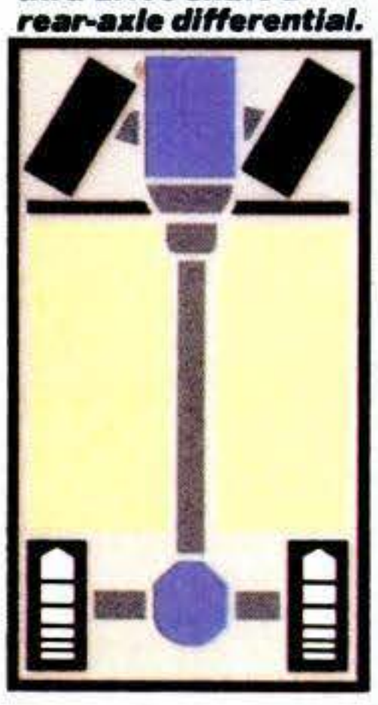
America's only front-wheel-dri

The Aries-K Direct Power System: The heart of Aries-K is the new Chrysler 2.2 litre Trans-4 engine designed specifically for front-wheel-drive. It's part of a Direct Power System that puts the engine directly over the front driving wheels of the car and allows power to flow directly to them.

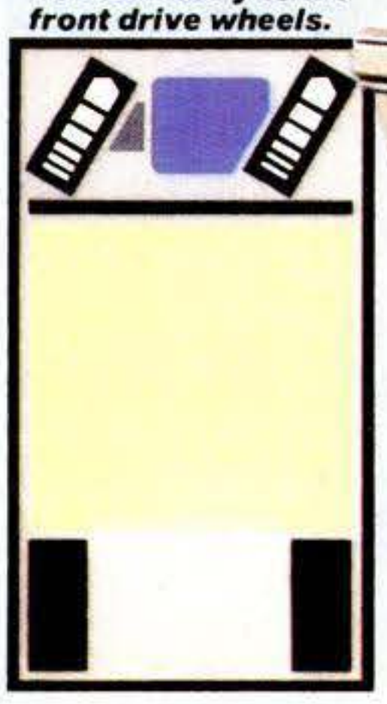
Trans-4: the engine with an electronic control computer. The Trans-4 is an engine with an electronic control computer, a sophisticated feed-back system. Chrysler's exclusive Electronic Fuel Control System that includes electronic ignition, electronic control of spark timing and electronic feedback carburetor; seven sensors located throughout the engine monitor functions and feed data to an on-board computer which continuously adjusts the timing and air/fuel ratio for optimum efficiency.

America's only front-wheel-drive 6-passenger wagon rated 24 EPA est mpg. 40 est Hwy.*

Rear-drive cars transmit engine power thru drive shaft & rear-axle differential.



In Dodge Aries-K Trans-4 engine power flows directly to the front drive wheels.



*Use est mpg for comparison. Your mileage may vary, depending on speed, weather and trip lengths. Actual highway mileage will probably be less. Calif. est lower. *Buy or lease at your Dodge dealer.*

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High mileage. And room for 6.
There are other cars on the road today that have mileage ratings as high as Aries-K. But none of them have the 6-passenger room Aries-K delivers. The reason: Chrysler front-wheel-drive.

Keeping the power train completely forward of the passenger compartment has a number of benefits. All of them make more room for people. Without a huge transmission hump, Aries-K has plenty of front leg room. Without the clumsy drive-shaft hump that runs the length of rear-drive cars, middle seat passengers in the new Aries-K don't have to sit with their knees tucked up under their chins.

In fact, the entire passenger compartment has been designed for lots of head room, shoulder room and hip room.

25/41
EPA EST. MPG EST. HWY*

6-passengers

"Service-Engineered" Aries-K. Simple to service. Designed inexpensive to maintain.
Aries-K was designed to make servicing as simple as possible. Many components that require scheduled maintenance are up front and easy to reach.

We eliminated many service operations other cars still require. Aries-K performs them automatically. And scheduled maintenance intervals have been extended.

ve 6-passenger car rated 25 41.

EPA EST. MPG EST. HWY*

Aries-K engines are handled with such care, that even a white glove inspection isn't permitted for fear of leaving lint on any part.
Our engineering goal was to build the highest quality car in its class in America. To help achieve that goal, Chrysler set up one of the most technologically advanced plants in the world with the most sophisticated assembly techniques. It's why Aries-K is backed up with a guarantee:

Satisfaction guaranteed or your money back.
If you're not satisfied with your new Dodge Aries-K, purchased for personal use from a participating dealer, bring it back in good condition and with no metal damage within 30 days or 1000 miles, whichever comes first. When the dealer gets clear title, you'll get your money back, excluding finance and insurance charges. Trade-in refund may differ from trade-in allowance on retail sales contract. Ask participating dealer for details.

With Aries-K pulling for you, America's not going to be pushed around anymore.

AMERICA'S NOT GOING TO BE PUSHED AROUND ANYMORE.

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Lincoln would have loved it.

When my wife and I came out here to build our own log cabin, we left everything behind.

Except for a few clothes, some camping gear, an old axe, and my John Deere Chain Saw.

Well, the clothes have come in handy, and so has the tent. But I would have been lost without the chain saw.

In the beginning, I tried using an axe, just like Lincoln. But in the time it took me to cut a good size tree, I could cut enough logs for a whole wall with the chain saw. It seemed to glide right through even the toughest wood.

As you can see, the house is almost finished. With all the work that went into it, I've really come to appreciate the kind of man that Lincoln must have been.

But I appreciate this John Deere Chain Saw a lot more.

Nothing Runs Like a Deere®

John Deere has seven Chain Saws, with guide bars from 10 to 27 inches. For a free folder, write John Deere, Dept. 52, Moline, IL 61265.

Double-duty heat pump

[*Continued*]

sulfide is a hygroscopic salt—when it absorbs moisture, it heats up. That's what happens when you mix caustic soda with water to clean a clogged drain—the water molecules chemically combine with the salt, forming a hydride and releasing heat. Sodium sulfide has an added advantage—it won't dissolve if it's just dampened with water vapor. So a tank of damp salt can provide a bank of stored heat for warming a house and heating water.

Once the salt cools, it can be "recharged" by solar energy or waste industrial heat. Heat dries the salt, giving it the potential to reabsorb moisture and regenerate chemical heat. The vapor driven off flows to a second container, where it condenses and is held ready to wet the salt again when direct solar energy falters. This reversible cycle can be repeated indefinitely.

But Tepidus is more than an energy-storage system—thanks to the crafty method Brunberg devised to provide the water essential to the process.

The salt tank is connected to the water tank via a single pipe. The system is sealed, and the air pumped out. At this ultralow surface pressure, water vaporizes at 10 deg. C (50 deg. F)—the temperature underground. So the water tank is plugged into the ground via a heat-exchanger coil.

Ground-water heat pump

"Upgrading of cold energy from the ground is the heat-pump action," says Kjell Bakken, managing director of the Tepidus company.

Because of the low pressure, there is already some water vapor present in the system. "By the nature of the salt used," adds Bakken, "if both tanks are at the same temperature, the vapor pressure on the salt is lower than the vapor pressure on the water.

"So two things happen. Because of the pressure differences, the salt wants to draw water vapor out of the water tank. That means the water needs to be evaporated. And to be evaporated it needs energy. That energy is taken from the outside—from the ground coil.

"When the vapor reaches the salt tank, it condenses. So you get back the heat taken from the ground at the same time as chemical energy is released in the hydration reaction."

The system reaches equilibrium when the temperature in the salt tank is 55 deg. C (131 deg. F) hotter than the water tank. Then the pressure in

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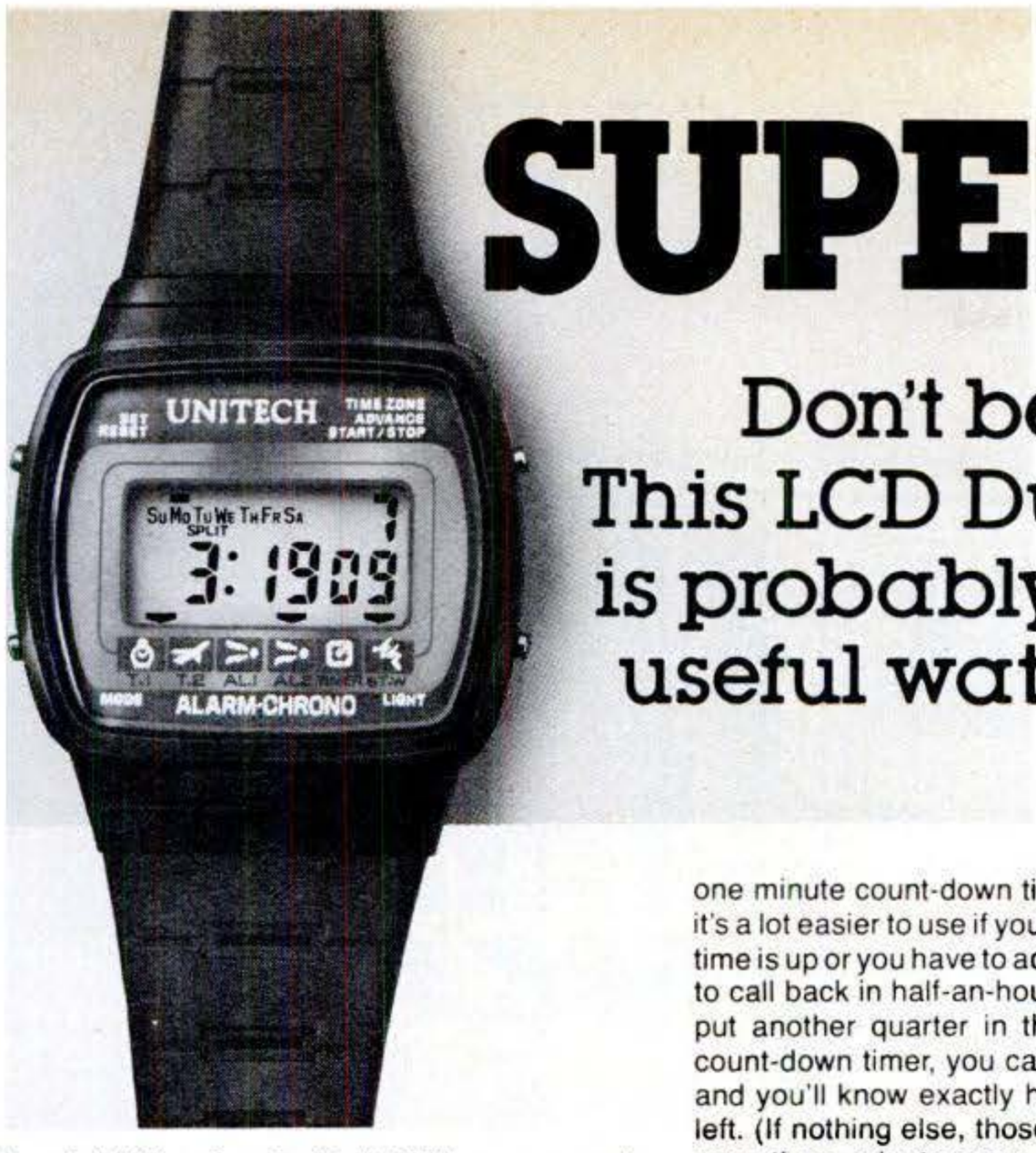

SUPER WATCH

Don't be fooled by the price. This LCD Dual Alarm Chronograph is probably the best as well as most useful watch on the market today.

This watch is in a class by itself. With every conceivable convenience ... unmatched feather-light comfort ... and rugged dependability with matching, trim-slim styling.

And it's priced so low, it makes sense to own as an every-day watch you can wear without worrying or as an extra watch you use only for running or when you're working around the house or for its wake-up alarm and second timekeeping zone when you're traveling.*

What's amazing is that it gives you TWO of everything other watches selling for ten times as much boast of when they have just one. And it includes additional conveniences, like a count-down timer; so, no other watch, at any price, does as much or does it better! And this watch is guaranteed for ONE full year.

WORLD CLASS ACCURACY: First and foremost it's guaranteed to be accurate to within seconds a month, three-minutes-a-year. You can be certain the big, easy-to-read display with the hour, minutes and running seconds is right on time—to the second.

Your watch also gives you the day and date at a glance, with no button to push, adjusting automatically for the number of days in any month (including leap year). Then, so you can see easily in the dark or when it's dim, there's a built-in night light.

3-YEAR BATTERY: And this is one watch you won't have to worry about for a long, long time. The battery is warranted to last for a full three years.

TWO-TIMING: What is more, you get a second timekeeping zone. A convenience you'll really appreciate when you travel or when you're doing business with a firm in a far-away city. Plus a two-note chime you can set to go off on the hour to keep the time from passing you by.

24-HOUR ALARMS AND PERSONAL REMINDER SYSTEM: The alarm can be set in an instant for any minute of any hour. The precision of a digital alarm is simply unbeatable. If you want, you can leave this alarm set for the same time every day because there's a SECOND alarm as well. With two alarms you'll be able to schedule your day and stick to your schedule more easily and surely than ever before.

30-MINUTES AND COUNTING: In addition, inspired by the Space Center, you also get a 12 hour to one minute count-down timer. Really, a third alarm, it's a lot easier to use if you want to be reminded your time is up or you have to act—when you've promised to call back in half-an-hour, for example, or have to put another quarter in the parking meter. With a count-down timer, you can be sure you won't goof, and you'll know exactly how much time you've got left. (If nothing else, those steaks you like rare and your three-minute eggs will never be over-done again.)

CHRONOGRAPH SYSTEM: With 1/100th of a second precision for up to 12 hours, the dual chronograph literally enables you to command time to stand still. With the stopwatch you can time any event in its entirety — from a speech you're preparing to the length of a phone call you're making to the time it takes a passer to set up and throw. (A buzzer sounds when you start or stop the chronograph. A nice feature since it means you won't have to check to see if it's timing.)

You can also measure sections of an event, like the time for the 1/4 or the 1/2 or the times of individual finishers in a race. This is Lap Time. In this mode the chronograph continues timing an event in memory at the same time that it's stopped to give you a reading on a particular segment.

You'll be able to use either of these modes in minutes, find innumerable uses for both in your business and personal life within days.

SUPER LIGHTWEIGHT: Even with all these functions, you'll hardly know you're wearing a watch. It's that light and comfortable. Less than one ounce.

The case, which is exceptionally handsome, is made of a high-impact, virtually impervious black plastic. An advance almost as remarkable in its way as those in the microprocessor that controls the watch's functions.

THE MOST IMPORTANT FEATURE OF ALL

Here's a watch, then, with phenomenal accuracy and totally unique capabilities; a watch that passed every quality-control test with flying colors and stood up to 10 years' of simulated-use tests. And all it costs is the amazing low price of just **$29.95!**

It just didn't seem possible to us either. But the manufacturer, who's been making components for years for many of the major watch companies, including some of the biggest, best-known names, explained:

"Of course, you'd expect it to sell for 100% more. But, once this new kind of case became available, we knew we could produce a chip (microprocessor) superior to any we made for anyone else, and sell it for far less than you'd expect by assembling the watches ourselves and selling them direct-by-mail, eliminating the middleman's mark-up in both manufacturing and selling."

As proof, in about a year, a major name in the watch world plans to buy this module and offer this same watch through normal retail outlets for at least $60 and maybe more.

ANOTHER CHOICE

This gave us an idea. What if the same watch was put in a stainless steel case with a stainless steel band. After some figuring the manufacturer said he'd include a deluxe mineral glass crystal, so the watch would be absolutely superb, and all we'd have to charge is just $59.95.

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(Nebraska residents call 800-642-8777)
(Numbers in operation 7 days a week, 24 hours a day)

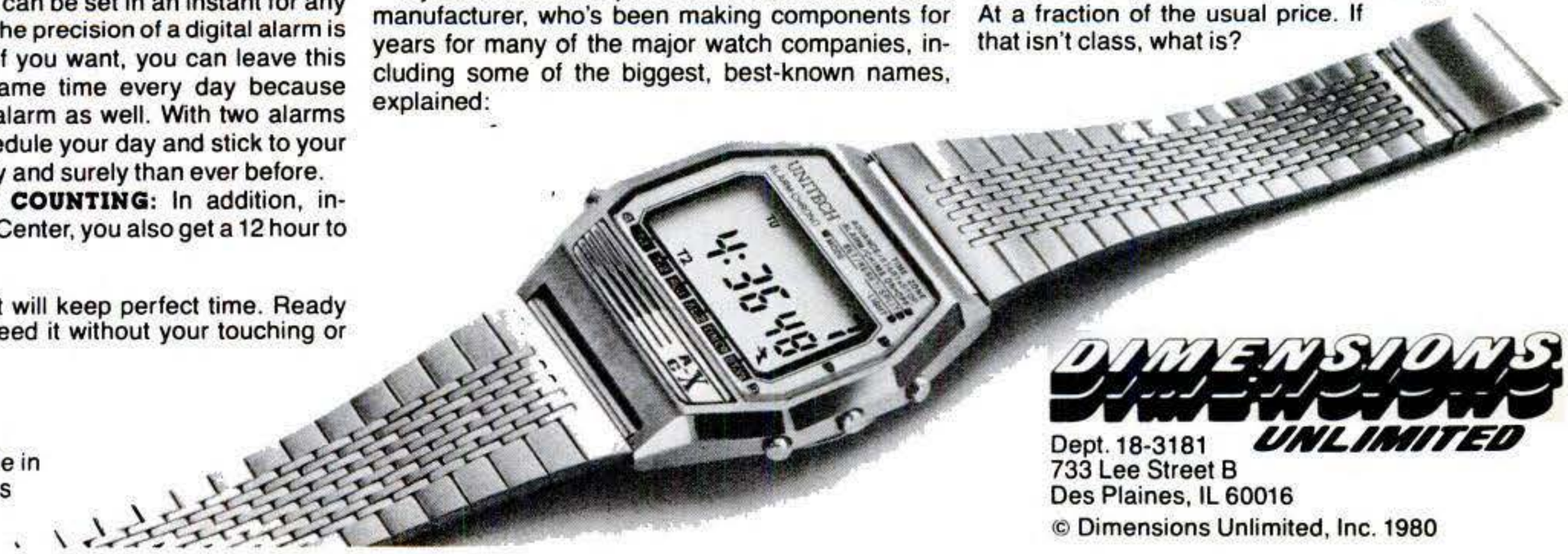
So, that's your choice of the matte black watch or the watch in stainless steel with a stainless bracelet.

What is more, since you can't get this watch in any store, we'll send it to you to wear for 30 days without risk or obligation. If you're not absolutely satisfied, if the accuracy isn't exactly as we say, if you don't find two timekeeping zones, the two alarms, the dual chronograph, the count-down timer as useful and convenient as you supposed, if people don't praise the look of the watch you're wearing, send it back for a complete refund. No questions asked.

To order with any major credit card, simply call the toll-free number above. But we'd prefer, in this instance, since the price is so much lower than for anything else we sell, that you send us your check to the address below. Just be sure to specify the Black Watch or the Stainless Steel Alarm Chronograph and include the proper amount. (Include $2.50 for shipping and handling and in Illinois the 6% sales tax.)

Either way, you'll be getting a watch as good if not better than any watch in the market today. At a fraction of the usual price. If that isn't class, what is?

*Even in a drawer, it will keep perfect time. Ready when you want or need it without your touching or adjusting a thing.



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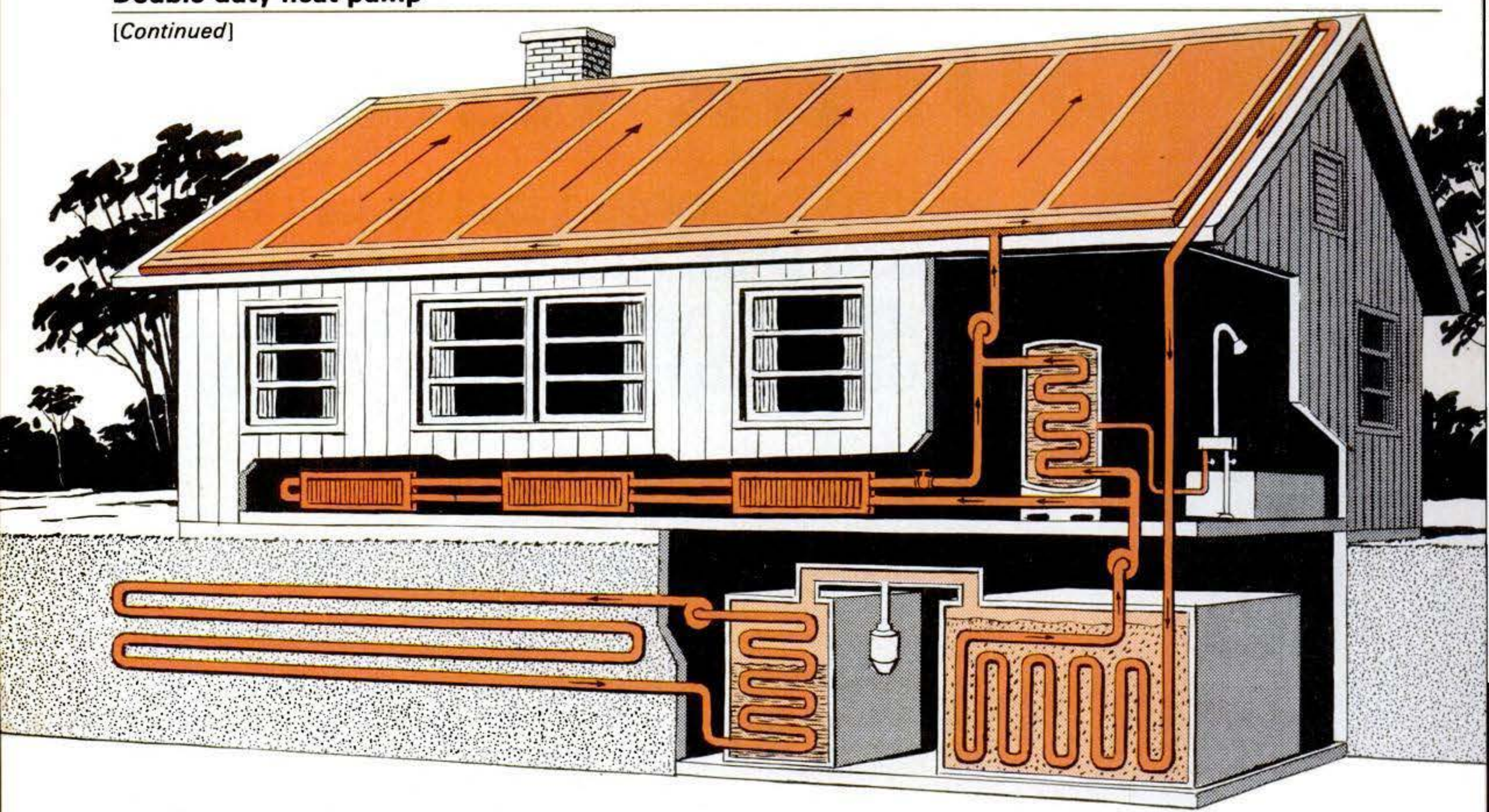

A tankful of hot salt can store enough solar energy for year-round house heating. The hygroscopic salt stores energy when heated—releasing that energy in a chemical reaction when it absorbs water to become a hydrate. Solar-heated hot water circulates through a heat exchanger in basement salt tank (right) before traveling back up to house radiators and the hot-water tank. Basement tank at left stores the water used for the heat-releasing reaction. This tank is cooled by water pumped through a buried heat exchanger. The sealed two-tank system is kept at low pressure (0.08 psi) by an automatic vacuum pump. At this low pressure, water in the cold tank vaporizes, extracting heat energy from the ground. When the water vapor travels over to dampen the salt, it not only generates heat through chemical reaction, it also condenses, giving up the heat taken from the ground. What draws the water vapor to the salt tank? A slight drop in pressure caused by the salt cooling as its heat is tapped for house systems when the solar system isn't functioning. When the solar system *is* working, a slight rise in temperature is enough to disturb the equilibrium in the other direction. The solar heat then drives off the vapor to the cold tank where it condenses, dissipating its heat to the ground. The dehydrated salt is now rich in energy since it has the potential to once again absorb water and give off heat. With regular solar input during the summer, this hot-to-cold vapor flow continues until the salt is completely dry. A valve seals off the dry salt tank while another is charged.

the two tanks is equal, and the chemical sponge no longer absorbs vapor. Disturb this balance, and vapor is released from one tank and flows to the other. The direction of flow depends on which way the temperature swings.

Because the system is so sensitive to minute pressure changes, the working temperature of the salt tank remains constant at about 65 degrees C. That's enough for radiators and tap water.

Energy-rich salt

But what about long-term energy storage? Tepidus has an enormous capacity. One kilogram of sodium sulfide can store and give back one kilowatt-hour (3413 Btu) of heat. In practical terms, that means that eight tons of the dry material can store and deliver 8000 kWh (27,304,000 Btu). That's enough to meet the space- and water-heating needs of a small, well insulated house. The energy input can come from solar power alone—even assuming half the year's energy collection has to be stored for winter.

Eight one-ton salt containers, each one meter square and 1.75 meters high, make a pretty massive bulk to fit in a basement. Their volume is around eight times that of an oil tank with the equivalent thermal content. But one load of salt lasts a lifetime and soon offsets the penalty of dead space.

And Tepidus is far ahead of other forms of heat storage, according to Bakken. One main rival is eutectic salts that rely on the heat released during phase-change [PS, Oct. '78]. "These have a capacity of about 100 watt-hours (341 Btu) per kilogram, one-tenth of our energy density," says Bakken. "And the stored energy doesn't last long because it's 'sensible' heat—perceptible to the touch—and is gradually lost to the environment.

"By contrast, ours is a low-temperature and long-term system. It can be switched off for an indefinite period and allowed to cool to room temperature. When it's started up again, only four or five percent of the total energy is used for reheating it."

And, in many installations, the storage tanks need not be so massive. The present system's capacity to store a full 50 percent of annual heating needs is calculated for Stockholm's latitude. At lower latitudes, solar input is more evenly spread around the seasons, so the solar collectors could take more of the direct heating load.

Portable heat energy

The system opens up exciting possibilities. Energy input could come from waste heat produced in factories, such as paper mills and steel plants, as well as from sunshine.

Portable heat is a further possibility. Since the energy potential is trapped in the dry salt when it is fully charged, the sealed tanks can be disconnected and moved for hookup to a distant system as an instant heat source. Brunberg's company is designing salt-tank cargo containers for

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FTC Report DEC. '79.

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So your videodeck won't pay for the sins of your videotape.

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Super Avilyn is different. It's a super-refined videotape especially developed by TDK. Super Avilyn particles are virtually inseparable from their strong binder. They stick to the tape as your videoheads spin at 1800 rpm. Pictures stay faithful to the original. Virtually no drop outs or color loss. Brilliance and crispness from beginning to end. Even during six-hour play, when the tape moves at a bare .43 inches per second.

Before we told you all this, you could have innocently hurt your deck. Now that you know all about Super Avilyn, it would be a sin to use anything else.

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The Vision of the Future

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You'll save up to 30% on fuel bills when you insulate and weatherstrip your house with an Arrow T-50 Staple Gun. You save your own energy, too — as well as labor costs! It's a breeze — one hand does it . . . one SQUEEZE and you've nailed it!

Just position gun, squeeze handle and presto . . . staple is driven into exact spot desired in 1/10th the time it takes to hammer a nail! Your other hand is always free to hold material in place for a neat, professional job!

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Double-duty heat pump

[*Continued*]

standard flatbed trucks. Surplus heat from nuclear generating stations and other plants could be delivered to remote areas in this way. Travel would be completely safe, since the tanks contain nothing explosive, and the dry salt has neither high temperature nor high pressure.

And since salt-tank modules can be any size, they could be scaled down for campers or pleasure boats. The salt could be charged by waste heat from the engine or at special heat-input stations at camp sites or marinas.

Finally, the system could also be used for air conditioning. Since the 55-deg.-C differential can be locked almost anywhere on the temperature scale, the heat exchanger for the water tank could be placed in the room to be cooled or in a cold box. Air in the cold box would hover near the freezing point as heat was extracted by evaporation inside the tank.

What are the snags? "We've fully proved the principle in our pilot plants," Bakken says. "Due to the late installation, long after the sun had left Scandinavia, we had to charge the system with resistance heating," he adds. "But it was fully loaded in February, and we heated the house from then on. Now we're charging the tanks again for winter."

Second testing system

Bakken also reports that another pilot system, with a storage capacity of about 30,000 kWh (102,390,000 Btu), has recently begun operating.

"The critical salt material has given no trouble," he says. "We've run 150 charge-discharge cycles already—which could equal 150 years' normal operation—and the salt has not deteriorated. But accelerated cycling isn't good enough, as it may give spurious results. Only when we are able to test complete systems for 30 years can we say there are no problems.

"Our goal now is to improve component design to cut production costs. There are no dark areas, only problems of technical detail. Heat exchangers, for example, become very expensive when you're handling lots of power."

Initial cost could be a problem. Bakken figures a complete Tepidus installation for an average family house would cost four or five times as much as an oil burner. But he notes that the solar collectors would be a major item. "And remember we're talking about a one-time investment that you have to balance against future bills." That balance could favor Tepidus as fossil fuels become costlier. PS

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In 1860, they hand-bottled the first small batch of Early Times.

Today, this special Heritage Edition is just as rare.

120 years ago, many a traveler went miles out of his way to enjoy the whisky made in a small distillery in Early Times, Kentucky.

Today, we're offering a limited supply of this exceptional spirit at a special 90.4 proof. Even the bottle, with its authentic look of hand-blown glass, reflects an earlier time. And because you will want to guard it a little more carefully than the other whiskies on your bar, it comes in its own wooden chest.

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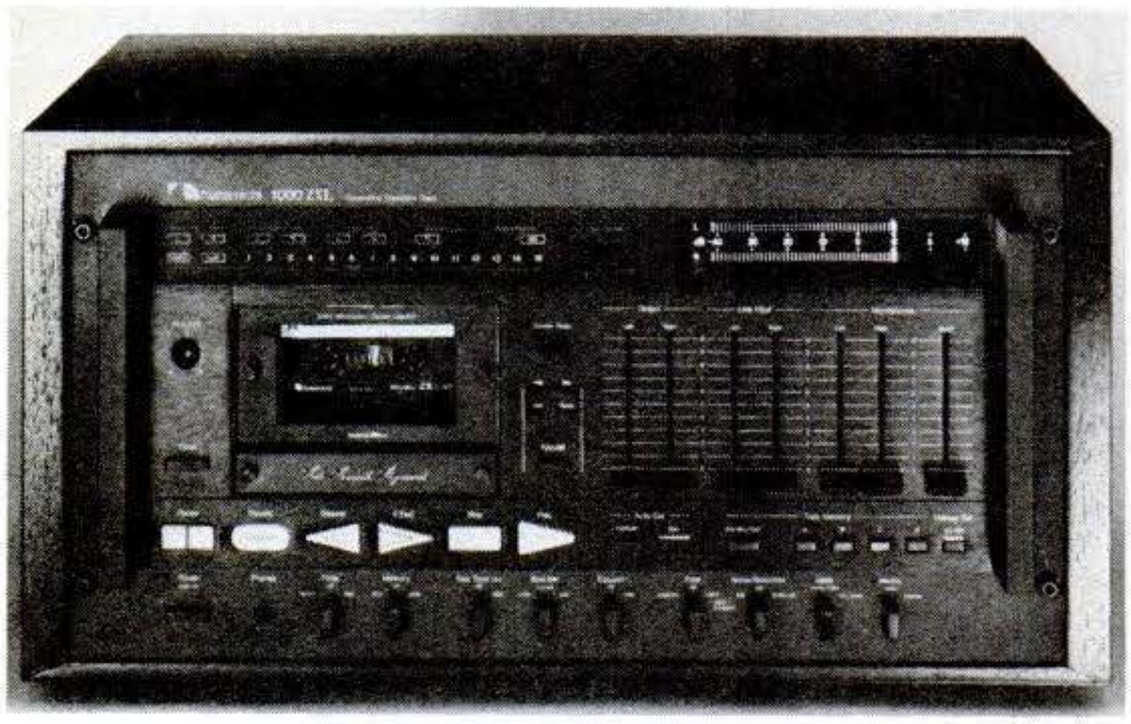
LOOK AND LISTEN

By JOHN FREE



Computing cassette deck

Nakamichi, noted for its state-of-the-art improvements in hi-fi cassette decks, has set a new high in performance with its computerized 1000ZXL. This new deck, shown at the summer Consumer Electronics Show in Chicago, uses its built-in microcomputer to optimize recording and playback circuits for each cassette tape. The computer puts a series of test tones on a tape, then rewinds it, plays back the tones, and stores the best bias, level, and equalization values for that tape in its memory. This 20-second automatic calibration technique isn't new with the 1000ZXL. Other firms introduced decks with similar capabilities last year [PS, Nov. '79].

But Nakamichi has a new twist. The microcomputer also helps mechanically align the separate recording and playback heads in the 1000ZXL for each cassette. Even minute misalignment in azimuth of these heads cuts high-frequency response sharply. Nakamichi has head azimuth alignment (manual and automatic versions) in some earlier decks. This mechanical alignment, which compensates for physical differences in cassette tapes and housings, combined with optimizing recorder circuits for each tape's magnetic properties, results in spectacular performance. With most quality tapes, the 1000ZXL provides a frequency response from 10 to 25,000 Hz ± 3 dB. Response is essentially flat (± 0.5 dB) from 20 to 20,000 Hz—a feat, Nakamichi points out, that has been impossible even on nondigital, professional open-reel machines.

The microcomputer in the 1000XZL can perform other tasks, such as coding up to 15 selections with inaudible signals, then searching for them at high speed and playing them back in any sequence. Among other features (too numerous to detail here), the deck is designed to prevent obsolescence: Bias can be altered for new types of tape, and a noise-reduction switch simplifies adding any external noise-reduction systems. For this top performance, you'd expect a record-setting price. Nakamichi won't disappoint you; the 1000ZXL goes for $3800.

The 1000ZXL's Rolls Royce bulkiness contrasts with other new decks I saw at the show. For many new cassette decks, the trend is toward highly compact designs to blend with the micro hi-fi components [PS, Jan.] that are now popular.

Video-disc update

Another combatant in the coming 1981 battle over video discs [PS, July] may be General Electric. GE announced just before the electronics show that it's discussing a joint venture with Japan's Matsushita and JVC and England's Thorn EMI Ltd. to market the VHD (video high density) disc system and its software (programming). The VHD system was demonstrated at the Consumer Electronics Show by Panasonic and JVC, both Matsushita subsidiaries. The giant Japanese firm says it may have VHD players on the market by late 1981. They would be priced to compete with RCA's under-$500 SelectaVision disc player, slated for introduction early in 1981. RCA recently dubbed its system CED, for Capacitance Electronic Disc; it will also be sold by Sears Roebuck.

Both the CED and VHD systems sense TV signals encoded as capacitance variations in discs when a stylus contacts the disc surface. But discs for one system are not compatible with the other. Magnavox and Pioneer both expect to market their optical systems ($700–$750) nationwide next year, too. Optical discs, played back by a laser beam, are compatible between the Pioneer and Magnavox players.

Higher-fi recordings

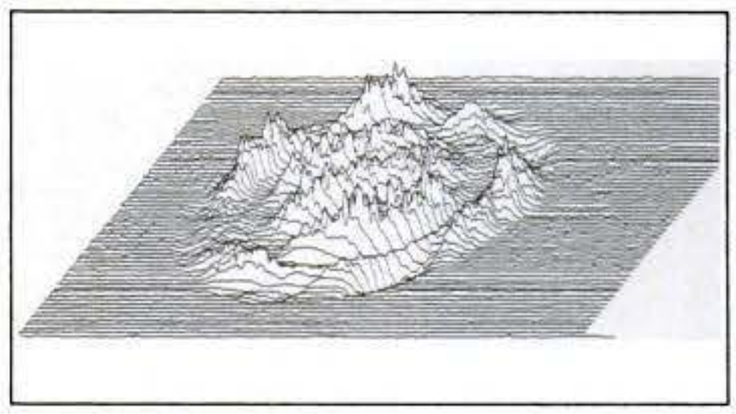
A growing number of small record companies have been releasing high-end ($15) discs made with special techniques and care for audiophiles with the equipment and ears to appreciate improved sound. Now, one of the major recording firms, CBS, has joined in with new recordings made from digital master tapes and a special pressing process for quieter disc surfaces. CBS is also re-releasing discs mastered from conventional analog master tapes remastered at half speed for less distortion and improved fidelity. In addition, CBS is releasing its original digital album series on chromium dioxide cassettes recorded at slower speed than normal for boosted fidelity.

For listeners with the equipment to play back DBX-encoded discs [PS, Dec. '79], three albums recorded by the London Symphony Orchestra have been released on the Varese Saraband and Chalfont labels. These discs combine the advantages of a digital master tape with the DBX process, which electronically compresses the audio signal before it goes on the master disc; a decoder in your hi-fi system then decompresses the signal, providing wide dynamic range with virtually no disc surface noise.

Meanwhile, as companies tinker with ways of improving conventional discs, N.V. Philips, which demonstrated its super-fidelity digital Compact Disc (CD) last year [PS, Oct. '79], says Sony has been aiding it with technical improvements. The CD system uses optical discs only 4.7 inches in diameter with one hour of music on one side. They fit in a cigar-box-size player and are scanned by a solid-state laser. Philips says its new disc format will become available sometime in the early 1980's.

Quick looks

- The FCC may reappraise its approval of Magnavox's AM stereo method [PS, July] after complaints from broadcasters and others.
- Cable-TV firms may now import as many channels as they want, and needn't black out syndicated programs broadcast by local channels, the FCC ruled.
- Comb-filter circuits that enhance resolution and cut interference [PS, Aug. '78] are now in many Magnavox, RCA, and Zenith color TV's and in some Toshiba, Quasar, and Sears models.



Frozen cones

"It has always been a designer's dream to view the vibrating surface of a speaker diaphragm as though its small vibration had been magnified a thousandfold and frozen in time," says Graham Bank, technical director of Celestion Industries, a British loudspeaker firm. Celestion turned the dream into reality, and one result (above) shows what a one-inch, hard-dome treble speaker looks like when driven with a 14.2-kHz signal. The new technique analyzes laser reflections from the loudspeaker surface and plots the results with a computer. PS

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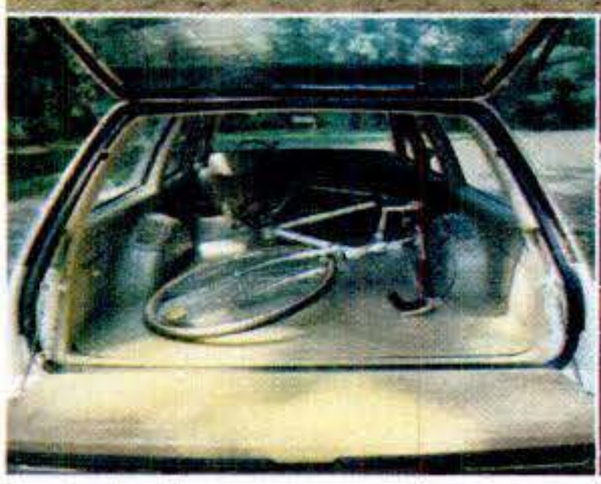
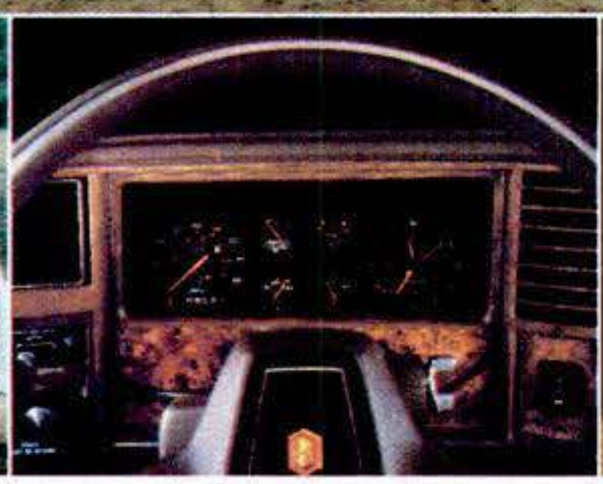
A family wagon even a bachelor could love.

1981 Malibu Classic Wagon.





It used to be you'd buy a station wagon not so much because you wanted to but because you had to. The family was getting bigger and you simply needed the room.

But times have changed.

People today are buying Chevy Malibu Wagons because they want to. Malibu's trim size makes it agile and easy to drive. When you get behind the wheel, if you don't look behind you, you're apt to think you're driving a coupe.

When you do turn around, you'll see there's over 71 cubic feet of load space with the rear seat down, easily accessible through Malibu's handy-dandy two-way hatchgate. There is also storage in both wheel wells and underneath the floor.

What we're saying is, while today's trim Malibu Wagon can still handle a load, it can also handle a road. You don't have to have a huge family to appreciate that.

Heck, you don't even have to be married.

Buy or lease it at your Chevy dealer's now.

'81 Chevy Malibu Chevrolet

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DETROIT REPORT

By JIM DUNNE

More alphabet soup

GM will add another letter-designated model to its lineup when the P-car is introduced in 1982½. P is the code letter for the Pontiac sports car that will have an unusual midship-engine chassis. With a 160-in. wheelbase and a shape like the Fiat X1/9, the P-car will compete just below the Corvette in price, offering stiff competition to small imported sports cars. The power train will be a turned-around Phoenix unit. Standard engine of the plastic-bodied car will be the 2.5-liter Pontiac four, but a turbocharged version of this and an optional V6 are possibilities for low-production, high-performance models. One unique styling feature: no visible grille. Projected fuel economy for the P-car is 25 mpg in city driving.

Springs are rebounding

Just a few years ago, foam cushioning in car seats became the trend, so much so that full-foam seats were predicted for many cars. Springs were passé. Now that trend has slowed, and it may be reversed. Foam is heavier than wire springs, so, with the emphasis on cutting weight in all cars, the return to springs seems inevitable. Actually, combinations of foam and springs will be used, the portions dictated by the comfort needs of each model. The auto makers will grudgingly go back to wire springs, with their more costly and complicated assembly. One-piece foam seats are easier to ship, store, and handle than the combination type.

It's incredible

One bad decision by GM in the midsize line is repeated in Chrysler's new Reliant and Aries. The rear side windows on four-door models do not roll down. They're fixed in place so rear-seat passengers must rely on tiny vent windows for fresh air. That's not adequate, as was proved on 1978-'80 Malibu and Le Mans sedans. While the design does provide somewhat more hip room, what's really surprising is that the fixed windows actually cost more to build than the roll-down type. According to Chrysler engineers, the vent-window assembly is 20 percent more expensive and is more difficult to install.

Tire tip-off

Some of the replacement tires sold at retail are rejects from the auto companies. Stricter standards from Detroit compel tire companies to take back less-than-perfect tires, and they sell them as replacements at retail tire outlets. They look the same as those on new cars, but they don't meet OEM (original equipment manufacturer) standards. Rejected OEM tires may be upgraded by the rubber companies by machining for roundness, or they may simply be rerouted to the retailer without correction. You pay for the rejects at the regular retail price. One tire company claims the quality of the rejects is nonetheless excellent. Since "marketing tradition has been to sell lower-quality tires to individuals," the company says there is no reason to change present policy.

Quality sells cars

A study by Chrysler Corp. shows that car buyers are less loyal today than they were in the past. Just five years ago, the chief reason new-car owners cited for buying a particular make was "previous experience." Today, that is 16th on the list, while "value for the money" and "quality of workmanship" rank at the top. That goes a long way toward explaining the boom in foreign-car sales. A separate study by *Autoweek,* the performance-oriented weekly magazine, confirms Chrysler's results: It found that quality was named most often as the reason for buying an import. Surprisingly, fuel economy came in only second.

Is Detroit listening? You bet. Chrysler and Ford have initiated new policies to give hourly workers a say in the quality of the product. At Chrysler, where the union president is on the board of directors, the involvement of workers comes right from the top. Individual assembly-line workers have a strong say in the level of quality, too. At Ford, an experimental program at some assembly plants gives workers the power to complain formally about the level of quality and, in certain extreme cases, call for shutdown of the line.

Chrysler engine switch

As part of the company recovery plan, Chrysler will deal closely with Peugeot in the future. This means that Peugeot four-cylinder engines will eventually replace the Volkswagen-based fours now used in Omni/Horizon. Chrysler intends to use a 1.6-liter gasoline four made by Peugeot. Starting in late 1981, Chrysler will buy 100,000 Peugeot engines, with the option of increasing that to 150,000 soon after. Reports also say that Chrysler will use a Peugeot four-cylinder diesel engine in its front-drive Reliant and Aries, a move that would give these cars the best fuel economy among American-built compacts. The agreement follows Peugeot's recent heavy financial support of Chrysler.

Roof option removed

The roof of the 1981 Ramcharger/Trail Duster is permanent; it can't be removed by the owner for that open-air feeling. Chrysler research found that the removable-roof feature had been mostly wasted. Only five percent of owners ever removed the roof, and a surprising number—12 percent—didn't even know the roof was convertible. The permanent-roof design gives a tighter seal that stops leaks, rattles, and wind noise.

No replacement for Chevette

General Motors won't replace the Chevette with a more up-to-date, front-wheel-drive design until the 1985 model year. Code-named the S-car, it will be introduced in Europe in 1983 and built here a year later. It will be smaller and lighter than the current Chevette, and 40+ mpg is expected on the highway from the four-passenger hatchback chassis.

In the mill at GM

- By 1983, when Cadillac switches its sedans to front-wheel drive, the V8 engine will be gone, and with it the interesting V8/V6/V4 engine [PS, Oct.] that is standard on all current de Villes. When the big engine is dropped, the advantage of shutting down cylinders for fuel-economy reasons will be gone. Don't count the variable-displacement engine out completely, though. "It's ideal for trucks," says Bob Templin, Cadillac's chief engineer.
- One big reason for the recent shortage of X-cars from GM is the shortage of four-cylinder engines. GM expected buyers of the Citation, Phoenix, Omega, and Skylark to order primarily V6's. But the 2.5-liter Pontiac-built four was ordered on more than half of all X-cars sold the first year. Pontiac couldn't keep up with demand. At one point, GM offered a $100 discount to X-car buyers who selected the V6.
- GM expects that, by 1985, four-cylinder engines will be used in 60 percent of its new cars, or in about the same proportion that V8's were used last year. The switch is the key to GM president Pete Estes' prediction of a corporate fuel-economy average of 31 mpg by 1985.
- A 60-degree V6 engine design, not yet in production, could be the basis for a four-engine family that would form the backbone for the biggest line of GM power plants. The prototype V6 has a three-liter (183 cu. in.) displacement, but it can be built in three other versions—a 2.5-liter V5, a two-liter V4, and a 1.5-liter slant three—simply by lopping off cylinders one at a time. The big bonus is commonality of parts. Water pumps, rods, valves, rings, pistons, rocker arms, push rods, and carburetors can be identical, which would make service easier and parts less expensive and more readily available. PS

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J.E., Marlboro, NJ

Pennzoil Oil Filters are precision engineered to provide a controlled flow of oil through the filter and, at the same time, trap a maximum number of contaminating particles throughout the life of the filter. Pennzoil full flow oil filters provide engine protection against wear resulting from dirt, dust, grit, metal particles, resin and sludge. Our filters contain specially treated resin impregnated paper media which offers maximum surface filtration with minimum resistance to flow.

Island Bound. I'm currently in the U.S. Navy and will be stationed in Bermuda. I'll be driving a new Plymouth Champ on the island. The speed limit in Bermuda is only 20 mph and I'll be driving only between 4,000-5,000 miles a year, a lot of the time in first or second gear. What advice do you have regarding oil and change intervals for these unusual driving conditions?

P.S., FPO San Francisco, CA

For your new Plymouth Champ, we recommend the use of Pennzoil Multi-Vis 10W-40. No special lubricants should be required. However, with only 4,000-5,000 miles a year operation, and low speed limits in Bermuda, we'd definitely recommend that the oil be drained every 90 days regardless of mileage.

A Toast To Your Tank. I have an older car and if I start using gasohol in it, instead of gasoline, do I then need to add some top oil to make up for the lost lead?

J.S.G., McMinnville, OR

No special oil is needed with the use of gasohol in your car. However, we do recommend that the fuel filter be replaced after two tankfuls of gasohol. The alcohol tends to loosen the dirt in your fuel tank and it is carried through the fuel line to the fuel filter. Once your fuel system has been cleaned out, the gasohol will help prevent dirt accumulation.

Watered Woes. Whenever it rains or is damp, my '73 just dies on the road after driving a short distance. After a few minutes, it starts up again without any problems. The car has a rebuilt carburetor and engine, a new fuel pump, but very little power. What do you think is the cause of this problem?

E.D.J., Mississauga, Ontario

Since the problem you are encountering occurs during wet conditions, we suggest you check the electrical system. Under wet driving conditions, small amounts of moisture can cause shorts in the system and cause stalling or sluggish engine operation. We suggest that you change the spark plug wires, air cleaner and possibly the distributor cap. Many a headache has been caused by a tiny crack in the distributor cap.

Noise Gallery. What is the difference between detonation and pre-ignition knock in a gasoline engine? What is it that one hears when an engine "pings" under acceleration or load?

D.P., East Hampton, CT

Detonation, pinging, and knocking are all terms referring to the audible knock which you hear in your automobile engine. During normal engine operation the spark flame travels across the combustion chamber in smooth progression with no abrupt changes in pressure. During detonation, however, a small portion of the unburned mixture ahead of the flame ignites spontaneously. It burns very rapidly and results in a shock wave which produces a knocking sound—known as detonation or pinging. Some of the causes of detonation include the use of low octane fuel, combustion chamber deposits, poor cooling, improper carburetion, and improper ignition timing. Pre-ignition (also referred to as run on) is caused by "hot spots" which ignite a portion of the mixture before it would normally start to burn. When the engine is shut off, hot spots on the surface of the spark plug or engine combustion chamber ignite the fuel and cause the engine to run on.

Planning Ahead. I own a '74 VW Dasher and do all my own work. Shortly, I'll be replacing the transaxle oil. The owner's manual recommends an SAE 80 or 80W-90 which meets military specification MIL-L-2105. I'd like to use Pennzoil Gear Lubricant 4096 if it meets this specification.

P.B., San Francisco, California

The Pennzoil product you need is called Pennzoil GL-4 Gear Lubricant SAE 80. It's a rather specialized oil and might not be readily available, but it can be ordered from any outlet stocking Pennzoil products. Pennzoil Gear Lubricant 4096 is a higher level additive oil and is not recommended where MIL-L-2105 is called for.

WE'RE OPEN TO QUESTIONS about motor oils, lubricants, engines. But, you can tell *us* a few things, too. Maybe you have discovered something interesting about motor oils or lubricants. Or you have a special reason for being a Pennzoil fan. We would like to hear from you. Write to: Pennzoil Company, Research Department, P. O. Box 808, Oil City, Pennsylvania 16301. Note: sorry no pictures or material can be returned. Letters chosen for publication are subject to revision necessary for publication requirements.

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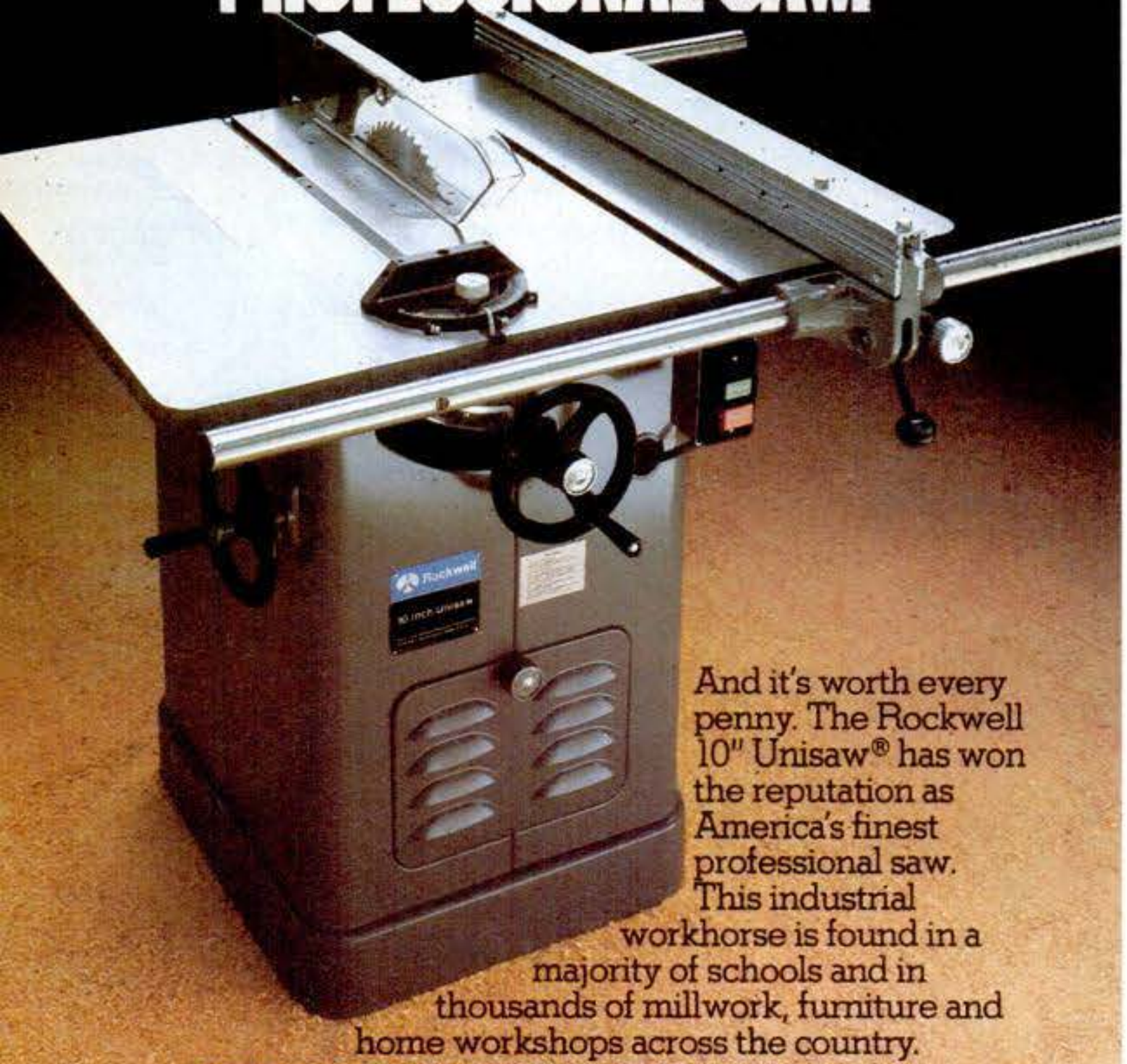

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THE ROCKWELL 10" UNISAW.

Prefabricated, preinsulated U-Form wall is hoisted into plac

Prefab sections
for high-rises

In Ypsilanti, Mich., the J.A. Ferguson Construction Co. recently built an eight-story apartment building, laying 15,000-sq.-ft. floors in five to seven days each. Yet, says Jack Ketai, architect in charge of the project, a masonry building that size usually takes 14–16 days per floor to build. Moreover, energy costs since the building's completion have averaged $12,000 a month less than those of conventional, similarly sized buildings.

These time and energy savings are attributable to a new building technique that uses prefabricated, preinsulated walls called U-Forms, manufactured by Universal Component Systems.

U-Forms are 11-in. thick, one-story-high walls that measure eight by eight feet. The walls are made of steel plate with a finished interior wall, backed by a layer of glass-fiber insulation. In the center of the form is a row of seven-in.-dia. tubes into which concrete is poured and steel reinforcing rods sunk. There then follows another layer of insulation against a finished exterior wall.

The selected exterior finish has already been applied when the U-Forms arrive at a building site. After strip footings are down, the U-Forms are hoisted into place. When the concrete has set and the first-floor slab's been tied into the U-Form components, inside work on the first floor begins while exterior work ascends to the second.

Since, after the completion of the first floor, interior and exterior work proceeds simultaneously, building time is sharply reduced. And there are no delays in winter; th built-in insulation keeps the concrete from freezing.

The insulation also cuts energy costs. Al Swerdlow, pres ident of Universal Component, says, "U-Form's double in sulation allows much smaller heating and cooling units t be used, drastically decreasing the energy load." He tells o a U-Form building in Lavonia, Mich: "Detroit Edison Co estimated energy costs in 1978 of $1 to $1.25 per sq. ft. pe year for thermally efficient conventional buildings in tha area. The U-Form building in Lavonia received bills aver aging 63¢ per sq. ft."—*Edward Moslander*

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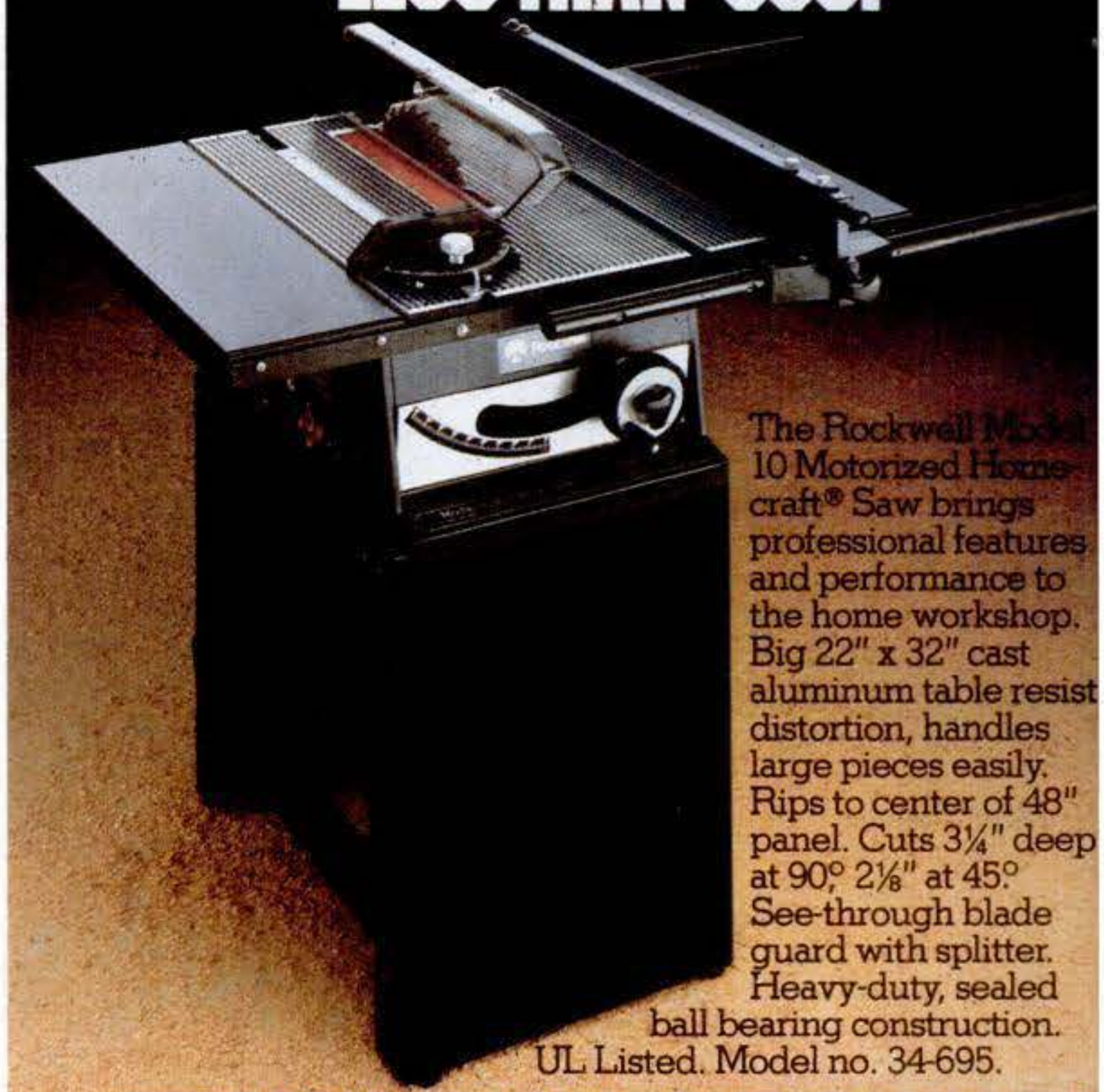

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THE ROCKWELL 10" HOMECRAFT SAW.

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Big mower
with sports-car steering

When all the chrome wheel covers and gimmicks cease to charm, the final judgment of a lawn and garden tractor must be: Will it cut thick, wet grass fast and efficiently year after year? My past experience with a 1968 Gravely had shown me that this was what I could expect from older models, but I had some misgivings about the new 8183-T 18-hp model.

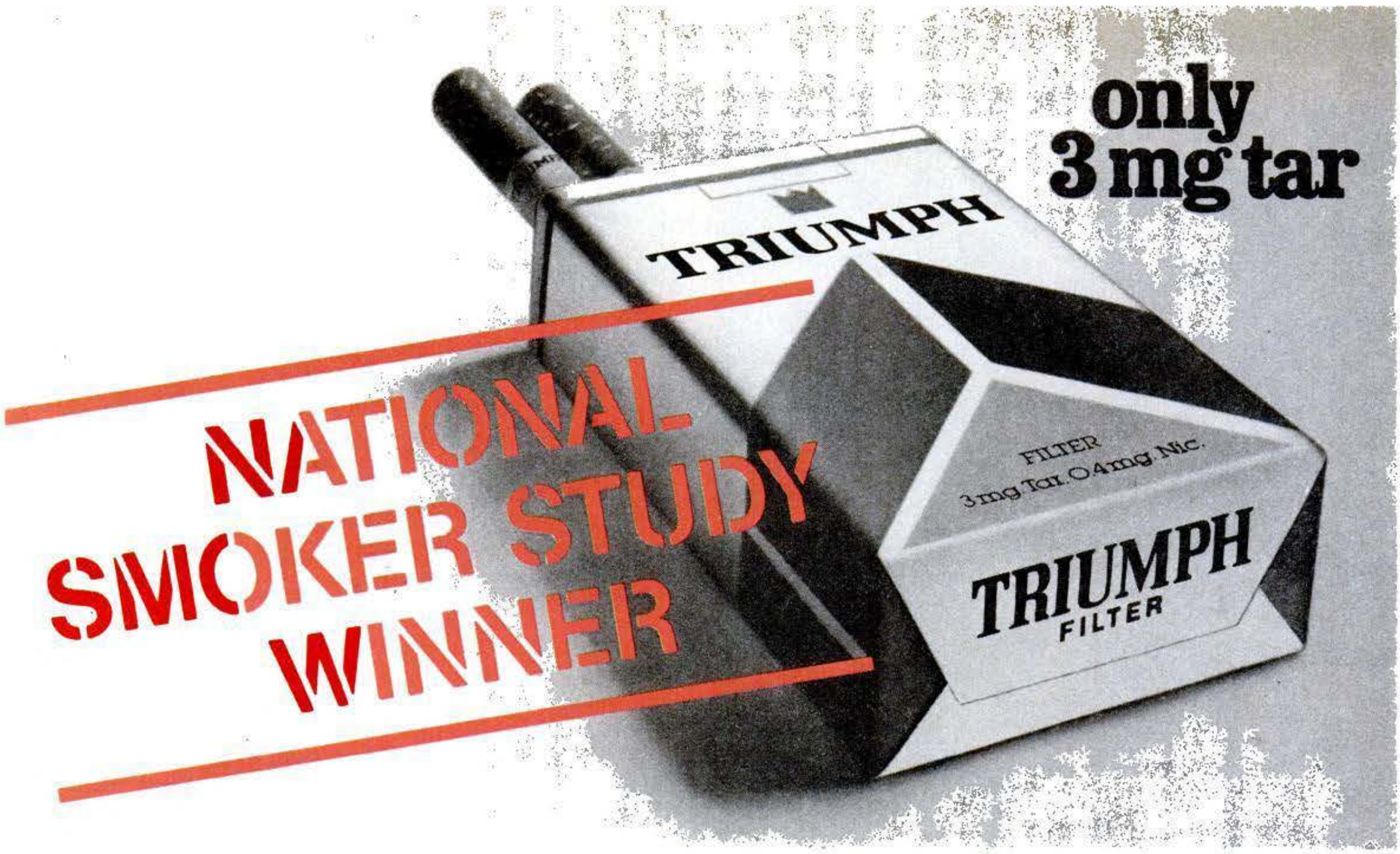
A quick side-by-side comparison of new and old showed some big differences: eight forward speeds instead of four; a new hydraulic lift for the 50-in. deck; and a smoother power-takeoff clutch. But I also found, I'm glad to say, the same massive front axle, cast-iron grille, and oversize cutter-blade shafts running in tapered roller bearings. The indestructible box frame and shaft and universal-joint drive are the same, too.

But still, 18-hp? I knew this extra power would be welcome when I put on the snowthrower or dozer, but would it help cut grass? And what about gas consumption?

In my testing, I only went as fast as second gear in the high range of the transmission. Even at that heady speed, there was no lugging down in the thickest spots. I mowed two acres in about an hour. After closing the main jet of the carb a little, I found that I could cut those two acres using two gallons of gas—about the same consumption as the older 10-hp model, but the amount of time spent cutting was considerably shorter with the newer, more powerful mower.

With its larger engine loafing most of the time, this mower isn't subject to those distressing pulldowns that tax smaller engines to their limit. And a new rack-and-pinion steering is the best I've found on any tractor. With this tractor's low center of gravity, you can whip around turns that would leave most tractors belly up.

Models are also available with 16-, 12-, and 10-hp engines. The 18-hp model lists for $4083, plus $625 for the deck. Gravely, Gravely Lane, Clemmons, N.C. 27012.—*E. F. Lindsley*



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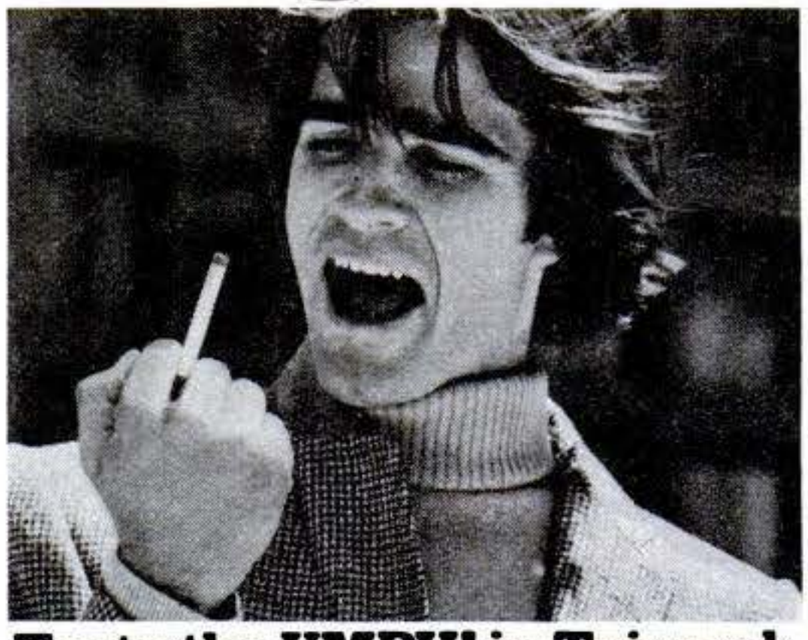

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3 mg. "tar," 0.4 mg. nicotine av. per cigarette, FTC Report Jan. 1980.

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Popular Science

PS | What's News

A decade ago, a computer with any capability at all filled a large room and cost hundreds of thousands of dollars. Today we have the home computer and the small business computer, which pack onto a desk top all the power and flexibility of those monster machines of a few years ago—and do it for only a few hundred dollars. It is just one of the incredible products that has grown out of striking advances in the field of microelectronic technology.

The trend toward miniaturization is not stopping with the desk-top computer. Now a new class of ultra-small, hand-held computers has emerged. Many deliver all the information-processing capability of the larger, desk-top units—and do it in a package you can drop into your briefcase.

The new hand-held computers caused a sensation at the Consumer Electronics Show in Chicago a few months ago, where most of them were first displayed in public. PS electronics editor Bill Hawkins, who was there, said the response was unbelievable. Crowds jammed the exhibits containing the new tiny computers. The exhibitors didn't even have to resort to the magicians, animal acts, singers, and even live bands they often use to attract crowds. The computers were easy to find, Bill reports. Just head for those booths surrounded by milling, jostling crowds.

Some of the units displayed at the show were engineering prototypes, others were just mock-ups—wooden blocks with paste-on paper panels designed to look like the ultimate device. In fact, the only actual working commercial device we were able to get our hands on during research for the article was the Sinclair ZX-80. And, we found, it really works, despite its tiny size. Associate editor Elaine Smay, who wrote the report in this issue, spent two days test-driving it through all its functions.

POPULAR SCIENCE readers, as you would expect, have shown strong interest in our past articles on home computers, so we thought this exciting new development—the emergence of a whole new category of subcompact models—was an important enough happening to put on our November cover. Art director Dave Houser and staff photographer John Keating conceived the idea of photographing a couple of the new units in the studio, then, for contrast, superimposing them over a scene that symbolized the old world of giant computers. The article begins on page 102.

Spinach power

Hydrogen is an almost perfect fuel. It is by far the most abundant chemical element found in nature, and it has the highest energy density of any known chemical fuel. Once it has been liberated from water, it can be used directly as a renewable, clean-burning fuel, as a means for storing or transporting energy, or as a chemical component from which other fuels such as methane and methanol can be made. That's why there has been serious effort over the years to develop ways of splitting water into its two components: hydrogen and oxygen [PS, June '78].

Water splitting can be done easily by electrolysis, of course. But that's a losing proposition. The hydrogen and oxygen atoms are so tightly bound that it takes more electrical energy to dissociate the elements than you get back later when you burn the hydrogen. Now, a team at Oak Ridge National Laboratory may have developed a way to overcome the problem. The team, led by Elias Greenbaum, uses photosynthesis to convert the energy of the sun into chemical energy.

In Greenbaum's experiment, spinach chloroplasts—the cell fragments containing the chlorophyll—are placed in a solution containing various substances, including special enzymes to speed the reaction. In effect, the energy of the sun is captured by the chloroplast, which is then tricked into using that energy to dissociate a molecule of water into its component parts, hydrogen and oxygen.

So far, the process is purely a laboratory demonstration, operated on a small scale. But it shows that ultimately we may be able to design a system able to produce practical quantities of hydrogen, operating on sun power alone.

Selling solar

The Center for Renewable Resources in Washington, D.C., is an organization made up of solar boosters whose goal is to encourage the development of various kinds of solar energy as quickly as possible. The center has just published a book called *Shining Examples,* which contains details on a number of outstanding solar projects around the country. It describes in considerable detail, for example:

- The world's largest solar greenhouse, built by senior citizens and teenagers in Cheyenne, Wyo., to produce vegetables locally.
- A project in Puerto Rico designed to show low-income people how to construct and install solar water heaters in their homes.
- A nonprofit mortgage corporation in California founded to grant loans to help homeowners buy solar equipment.
- A crab-processing plant in Alaska that used to have trouble disposing of the residues left after cleaning crabs. It now turns the waste product into 1500 cubic feet of methane a day by means of a methane digester.
- A shopping center in Vermont that burned $1200 worth of wood last year, saving $20,000 worth of oil.

The center says that while the solar age is not dawning with the speed of light, it is happening more rapidly than most people think. A survey, which the center called "by no means exhaustive," turned up some 2000 renewable energy projects involving sunlight, biomass, wind power, water power, and other sun-derived sources. The study indicates that more than 300,000 American homes are now using some kind of solar heating equipment or techniques, and that the sun supplies approximately five percent of our energy needs. Most of that, of course, comes from hydro power. The center estimates that 25 percent of our total energy needs could come from solar and other renewable sources by the year 2000. Most experts think that figure is somewhat optimistic, but whatever the specific percentage may be, it is clear that solar is, indeed, becoming an important part of our energy mix and doing it at a rapid rate.

C A Gilmore

Editor-in-Chief

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Do we need the breeder?

PHOTO BY ARTHUR I

Britain's 250-megawatt Prototype Fast (breeder) Reactor began generating electricity at Dounreay in northern Scotland in 1974.

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Pick the correct statement: A) We must start building a breeder reactor now to avoid energy chaos. B) Breeders are both dangerous and unnecessary

By EDWARD EDELSON

The three 25-foot-high black domes that I saw as we drove up to the undistinguished F. W. Hake warehouse on President's Island in Memphis didn't seem especially dramatic. Nor did the half-dozen or so tarpaulin-covered tanks that loomed inside the shadowy building, for all their massive presence.

But for knowing eyes, the drama was there—the drama of the tough decisions that must be made as mankind tries to find a way out of the global energy crisis. Standing in the warehouse, I was looking at some visible evidence of the questions that must be answered as the experts try to determine whether the world should follow a nuclear path to energy abundance.

The $16 million worth of equipment in the warehouse and the $22 million in components at the CBI nuclear plant at the other end of the island are part of a whopping half billion dollars in hardware already fabricated or under construction for a new kind of nuclear reactor, the Clinch River Breeder Reactor. But it is one that the Carter administration has vowed will never be built.

Supporters of the Clinch River project are openly dismayed by the administration's stand. They see the Clinch River breeder as the prototype of a new generation of reactors that will provide an almost limitless supply of electricity. "Building this is saying that we want more electricity, rather than doing without," I was told by William F. Rolf, general manager of the Clinch River plant. "That's what I think the country wants."

But opponents say that breeder reactors, in general—and Clinch River, in particular—are the wrong way to go, for any number of reasons. "I don't think the breeder pays on the basis of nuclear proliferation, safety, or economics," said Thomas B. Cochran of the Natural Resources Defense Council. "It has all the problems of general fission reactors and some of its own."

Conservation is not the answer

The debate between the supporters and opponents of the breeder reflects gnawing anxieties over the world's energy future. The supply of nonrenewable fossil fuels—oil, gas, coal—is steadily dwindling. Conservation can stem the hemorrhage, but only for so long. Thus there is an increasing clamor for a gradual transition to renewable-resource methods, such as biomass, solar energy, and eventually nuclear fusion.

But uranium—the radioactive substance that fuels existing nuclear reactors—is also being depleted. The whole point of the breeder is to turn uranium into a renewable resource by "breeding" more fuel—in the form of plutonium—than it consumes, thereby providing us with reactor-generated electricity for centuries. Without the breeder, nuclear energy could pass from the world scene as fast as oil promises to do. A report from the Government Accounting Office last year stated the issue baldly: "Breeders are the essential ingredient of making nuclear fission a long-term energy source. A decision not to develop breeders implies the phasing out of nuclear fission. . . ."

Do we really, then, need the breeder? Its opponents say no. The major objection is pinned to the very thing that makes the breeder so attractive to its supporters: A breeder makes plutonium. And plutonium, unlike the commonly found form of uranium, can easily be made into nuclear weapons, either by maverick governments or by determined terrorist groups. The prospect of the unhindered spread of nuclear weapons—the proliferation issue—is what prompted President Carter in April 1977 to halt construction of the Clinch River plant, to suspend reprocessing of spent fuel from conventional reactors (which also yields plutonium), and to urge other nations to follow his lead.

And, say the breeder's opponents, there are other objections. They say that the breeder's complex technology makes it basically unsafe; that on purely economic grounds it is unsound; that because we have enough uranium to bridge the gap between fission and fusion (or other energy sources) it is unnecessary; and finally, that even if it turns out we will need the breeder, we won't have to make that decision for another five years or so.

The perplexed citizen trying to sort out these conflicting claims must understand, first of all, the differences between the breeder and a conventional fission reactor.

Today's nuclear industry is based entirely on uranium-235, which makes up just 0.7 percent of mined uranium. The other 99.3 percent is U-238, which is not usable as nuclear fuel. That natural supply can be stretched somewhat, because today's reactors do produce some plutonium and uranium that can be used as fuel. But the current reactors (sometimes called "converters" to distinguish them from breeders) produce only six atoms of fuel for every 10 they use. Build enough reactors, and eventually all the natural fuel will be gone—unless mankind does something to replenish the supply.

That fact was recognized at the very beginning of the atomic age, when physicists started down what some of them thought would be a smooth, unbroken road to a breeder-reactor economy. The Manhattan Project included a reactor called Clementine, which incorporated some basic features of current breeder reactors.

The basic principle of all reactors is the same. Each has a core made up of hundreds of fuel rods. A fuel rod in one of today's commercial reactors consists mostly of U-238, with about three percent U-235, all wrapped in a protective jacket made of an alloy called Zircaloy. The U-235 atoms fission, or split, spontaneously. When a U-235 atom fissions, it gives off several neutrons. Those neutrons can hit other U-235 atoms, causing them to fission and to emit more neutrons, which strike more U-235 atoms—the celebrated "chain reaction." Some of the neutrons hit U-238 atoms, turning them into plutonium atoms that are fissionable and thus are usable as fuel.

> "Building this is saying we want more electricity, rather than doing without. That's what I think the country wants"

Light-water slowdown

Current nuclear reactors keep all the neutrons within the core by slowing them down. The neutrons are slowed by a "moderator"—which turns out to be plain water. The water not only slows the neutrons but also carries the heat from the core to a steam generator, which produces electricity. Thus, current reactors are called "light-water reactors" (a name deriving from the finicky scientific desire to distinguish ordinary water from the "heavy water" that contains the unusual hydrogen isotope called deuterium).

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By contrast, Clementine used fast neutrons, meaning that nothing was done to slow the neutrons emitted by fissioning atoms. Some of the fast neutrons could stream out of the core. If the core were surrounded by a thick blanket of U-238, many of the atoms in the blanket would be transformed into plutonium. If the core and the blanket are properly designed, the reactor breeds more nuclear fuel than it consumes, making it an efficient and desirable source of energy.

As early as 1963, a commercial breeder reactor was operating in the United States—the Enrico Fermi plant, built by Detroit Edison. But the first signs of trouble with the American breeder program soon appeared. A zirconium plate—added, ironically, as part of an extra safety system—came loose and blocked the flow of coolant to the nuclear core. Part of the core melted, and the plant had to be shut down for long and expensive repairs. The Fermi plant eventually went into full operation, but it was closed down permanently at the end of 1971, in large part because of financial problems caused by the accident.

> "I don't think the breeder pays on the basis of nuclear proliferation, safety, or economics. It has all the problems of general fission reactors and some of its own"

The Fermi incident was just one symptom of what have turned out to be chronic difficulties with the American breeder program, which has steadily lost the clear lead it once had over the rest of the world. The United States now stands solidly in fourth place in the development of the breeder reactor.

The French are clearly first, having laid out a breeder program with relentless Gallic logic. An experimental reactor named Rhapsodie, which produced 20 megawatts of heat (a megawatt is one million watts), went into operation in 1967; its heat output was doubled by design improvements in 1971. The Phenix reactor, with a capacity of 250 megawatts of electricity, went into operation in 1973. The French are now building Super Phenix, with a design capacity of 1200 megawatts of electricity and an on-line target date of 1982. And this year, Electricite de France, the state-owned authority, said that it will order two 1500-megawatt breeder reactors, to be put into operation by 1985.

The British and the Soviets are not far behind the French. The British have been running their 250-megawatt Prototype Fast Reactor at Dounreay in Scotland since 1974. They have plans for a 1300-megawatt commercial demonstration reactor whose construction would start by 1985, with an on-line target date of the early-to-mid-1990's. A Soviet 350-megawatt breeder has been operating since 1973 at Shevchenko on the Caspian Sea, and a 600-megawatt breeder at Beloyarsk in the Ural Mountains went into operation early this year.

Obviously, the view from Europe is drastically different from that of the U.S. government. C. Pierre Zaleski, a leader of the French nuclear effort, said he could understand why the U.S. is holding back on the breeder. "It's clear that you are less vulnerable to an energy shortage in the immediate future," Zaleski told me. "Only 20 percent of your energy is imported. We import 77 percent of our total energy. For us, the breeder reactor comes down to a question of survival."

John Gaunt, a nuclear expert at the British embassy in Washington, D.C., told me that even with North Sea oil finds, the breeder reactor seems essential for his nation. The oil will run out eventually, Gaunt said, and the obvious alternative is the plutonium that Britain is already extracting from the fuel elements of its Magnox nuclear reactors. "We have about 10 tons of extracted plutonium," he said. "By the end of the century, we will have about 40 tons. We will also have 20,000 tons of depleted uranium. That is the energy equivalent of five times the oil in the North Sea. That is not to be sneezed at."

Fear of weapon construction

But it is exactly the thought of all the plutonium that would be available if the world turns to a breeder-reactor economy that has helped to cast a chill over the U.S. breeder program. Disarmament experts are especially disturbed by their belief that plutonium from a breeder reactor could be used to construct nuclear weapons with remarkable ease.

Studies done for the U.S. Arms Control and Disarmament Agency show that light-water reactors are rather proliferation-resistant. A country that wants to extract weapons-grade material from used fuel rods has to go out of its way to build a complex and expensive fuel-reprocessing plant. Such a plant is not really necessary for operating a light-water reactor, so construction would be a clear signal to the world that a nation was on the path to nuclear weapons. By contrast, fuel reprocessing is an essential part of a breeder-reactor economy. The whole point of the breeder reactor is to extract plutonium from used fuel rods. That plutonium can be turned into weapons-grade material in a matter of days—and a single breeder core yields enough plutonium for hundreds of bombs.

Energy-hungry European nations have not bought the U.S. government's anti-proliferation arguments. But in October 1977, everyone agreed to a broad-based study. The International Nuclear Fuel Cycle Evaluation (INFCE), which had eight working groups, eventually included 66 nations, and handed down a voluminous bundle of findings last spring.

One of the major points of the INFCE report supported something that breeder opponents have been saying for years: There is no technical fix for the proliferation problem. A number of schemes had been proposed to make weapon construction more difficult. One is the CIVEX fuel-processing plan, which would leave a large proportion of the lethal radioactive byproducts of fission in the processed uranium. Radiation would be so deadly that no one who came near the fuel could survive long enough to build a bomb. Another proposal is to switch to a fuel cycle based on uranium-233, another fissionable isotope, and thorium on the grounds that much less plutonium would be produced. INFCE's experts concluded that none of the schemes would work. The only way to handle the weapons-proliferation problem, the experts said, is by political agreements—for example, by requiring storage of all plutonium under international supervision.

The proliferation problem does not appear to worry European nuclear leaders. The genie is already out of the bottle, Zaleskie told me: Nuclear fuel is being reprocessed to yield plutonium, hundreds of nuclear weapons are in place, and the addition of breeder reactors will not make much of a difference. British Prime Minister Margaret Thatcher summed up one prevalent point of view about plutonium

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when she said that "the safest thing is to burn it in a fast reactor."

European nuclear experts also say that the safety of breeder reactors is not a major issue. Opponents disagree, and say that there are several serious weak points in breeder safety.

One is the use of highly enriched fuel in the core of a breeder reactor. There is a good deal of plutonium in the breeder core, and some studies say that if a meltdown began, parts of the core could have enough fissionable material for a minor explosion—"minor" by nuclear standards, that is. There are worries about whether such an explosion could break through the reactor's containment vessels. (Such an explosion cannot occur in a light-water reactor, because its fuel is not highly enriched. It can melt, but it can't blow up.)

There's also the problem posed by the coolant used in breeder reactors. Every program is concentrating on LMFBR's—Liquid Metal Fast Breeder Reactors. The liquid metal is sodium, which transfers heat given off by the core to the water, which becomes steam that turns an electric generator. Sodium is used because it can store a large amount of heat per unit volume and liquefies at relatively low temperatures. It also reacts violently with both water and air. The Soviet breeder at Shevchenko had a major fire in 1973 when a sodium line burst, and critics say that sodium fires are a constant threat for any breeder.

But Zaleskie says that sodium has some safety advantages over light water as a coolant. The biggest advantage is that sodium in a breeder is not kept under the high pressure that is needed for water in a light-water reactor. The big problem at the Three Mile Island reactor, for example, was that pressurized water came roaring out of the reactor, exposing the core and allowing a dangerous buildup of heat. In a similar situation, sodium in a breeder will just lie there, carrying away heat as it should, Zaleskie said. Gaunt adds that the British have run a number of tests in which they stopped pumping sodium through a breeder. Heat built up so slowly that the reactor would have been safe for months, compared to the few minutes' margin of safety in a light-water-reactor accident, he said.

> **"If I were in France, I'd be working as hard on a breeder reactor as I could. They don't have oil, they don't have natural gas, they don't have uranium, and they don't have coal"**

As for the possibility of an explosion, breeder proponents say that one simply calculates the maximum possible explosion and builds a containment vessel strong enough to sustain it—a strategy that is greeted with predictable skepticism by breeder opponents.

Different in America

One intriguing thought behind these arguments is that the European situation might be so different from ours that their reasoning has to be different. "If I were in France, I'd be working as hard on a breeder reactor as I could," said Marvin Moss, associate director of energy research for the U.S. Department of Energy. "They don't have oil, they don't have natural gas, they don't have uranium, and they don't have coal."

It's different here—different enough so that several studies have concluded that we can delay a decision about going ahead with a breeder for at least five years and perhaps much longer. Those studies are, of course, challenged by breeder proponents.

One important element in the breeder decision is the fact that the U.S. will be using much less nuclear energy in the foreseeable future than was predicted when the breeder program began. In 1972, the Atomic Energy Commission forecast that there would be 1200 gigawatts of nuclear electricity on line in the U.S. by the year 2000. (A gigawatt is 1000 megawatts.) Last January, Secretary of Energy Charles Duncan told a congressional committee that "nuclear capacity in the United States appears likely to increase from current levels of about 50 gigawatts to 150–200 gigawatts by 2000."

Some exult over that decline, as a sign that Americans are at least learning to conserve energy. Others agonize over it, as a sign of American technological deterioration. But given the long lead time for building new nuclear plants—about 12 years in the current regulatory climate—most experts accept those numbers and move on to calculate when we might need the breeder because we would be running out of uranium.

A standard 1000-megawatt nuclear plant of current design will use about 4300 tons of uranium for a 30-year lifetime. Therefore, 200 gigawatts of nuclear power on line in the year 2000 would require roughly one million tons of uranium. The official estimate by the National Uranium Resource Evaluation group is that 4.1 million tons of uranium will be available in the United States if the price is $50 per pound of uranium. (The current price is $40 a pound.)

But there is enormous uncertainty in that estimate, since it includes much uranium that has not yet been discovered but is assumed to be there. Looking at the same geological data, the massive study of the Committee on Nuclear and Alternative Energy Systems (CONAES) estimated the supply to be 2.4 million tons.

Comparing the economic elements

And the economics of the breeder reactor must also be part of the equation. Even if we make a total commitment to the breeder, it would not make sense to start building commercial breeder reactors until they are economically competitive with light-water reactors. Fuel costs are only one part of the economic equation. Capital costs—the price of building the breeder—must also be considered in determining economic feasibility.

Breeder capital costs will be higher than light-water reactor costs; the question is how much higher. The current generation of demonstration breeders cost at least twice as much as off-the-shelf light-water reactors. Breeder experts say that commercialized products will cost only about 40 percent more, and that much of that difference will be recouped by fuel reprocessing.

No way, says breeder opponent Thomas Cochran. "To get down to 40 percent more capital costs, they have to do a lot of arm-waving and talking about learning curves and mass production," Cochran said. "Those are the same kinds of arguments they made in the early 1970's for the light-water reactors. They said the costs would go down as they moved along the learning curve. In fact, they went way up."

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The argument that fuel reprocessing will save money is greeted with the same skepticism by doubters. In a report for the Arms Control and Disarmament Agency, Brian Chow of Pan Heuristics quotes German figures showing that costs of a proposed reprocessing plant there more than quadrupled. Current U.S. estimates for fuel-reprocessing costs "should be considered unrealistically low," Chow said.

Opponents also claim that fuel-reprocessing technology is a tough beast to tame. The only plant ever to operate in the United States, at West Valley, N.Y., was open for only six years. It closed in 1972 for a modernization program that initially was estimated to cost $15 million. Safety requirements added by federal nuclear officials raised that estimate to $600 million, so prohibitively high that the plant was abandoned by the corporation that operated it. The legacy of West Valley includes 600,000 gallons of high-level radioactive waste whose disposal could cost more than one billion dollars.

The new French reprocessing plant at Cap de la Hague, near Cherbourg, had a potentially major incident last April 16, when it lost all electric power for an hour. Experts said that serious trouble was avoided only because the plant was not yet in production.

The need for such expensive and possibly dangerous fuel reprocessing can be put off for years by technological fixes that stretch the current supply of uranium, some experts say. One technique is to change the composition of light-water-reactor fuel rods to get more "burnup"—more energy out of the same amount of uranium.

> "If we proceed with Clinch River, by 1988 we'll have a 350-megawatt plant. That would be 15 years after the French and the Soviets had the same thing. We must leapfrog if we want to maintain our position"

New fuel rods already in advanced testing give 15 percent more energy than fuel elements now in use. The lifetime of today's fuel rods is limited by cracking that is caused by an interaction between the uranium and the Zircaloy cladding. Designers of the fuel rods now being tested are trying to eliminate the cracks either by adding a copper or zirconium lining or by coating the uranium with graphite. If the fuel rods last longer, more of the uranium will be burned up, and more energy will be extracted from each fuel rod.

Further down the road are changes that could give another 15 percent increase in light-water-reactor efficiency. One change would be the addition of some heavy water to the reactor, which would also switch to a thorium-uranium-233 fuel cycle. Such changes, which could be incorporated in reactors coming on line toward the end of the century, could reduce uranium demand by more than 50 percent.

Squeezing out the atoms

The Department of Energy is also looking at ways of getting more uranium-235 atoms out of uranium ore. There are 70 atoms of U-235 in every 1000 atoms of natural uranium. The current enrichment method extracts about 50 of those U-235 atoms. It combines uranium with fluorine to form a gas, uranium hexafluoride. The gas molecules then are sent through porous barriers. Because the gas atoms with U-235 are lighter than those with U-238, more of them get through the barriers, and the gas becomes progressively richer in U-235. Unfortunately, the process not only uses large amounts of energy but also leaves much U-235 behind.

Several experimental enrichment methods use laser light to separate out U-235 with greater efficiency and less energy. The two uranium isotopes cannot be separated by ordinary chemical methods because their chemical behavior is identical. But they absorb slightly different wavelengths of light. If just the right wavelength of laser light is used, only the U-235 atoms will absorb the energy from the laser beam. That absorbed energy allows the efficient separation of the U-235 atoms from the U-238 atoms. Such advanced technology could get 15 of the 20 currently wasted U-235 atoms separated out, increasing the effective supply of uranium.

The Department of Energy cranked all those numbers into a model last year and came out with numbers that sounded like bad news for supporters of an all-out program to commercialize breeders.

"The range for the year in which a commercial breeder would be needed was from 2005 to greater than 2050, and the majority of the numbers were at the higher end," said Marvin Moss. "We felt that the year 2020 was a prudent estimate to select. To commercialize the breeder in 2020, we would have to make a decision on a demonstration breeder probably by 1985."

The DOE report brought a predictably acid response from the Government Accounting Office, which works for Congress—predictable because Congress and the Carter administration are at odds about the Clinch River program. For the past few years, Clinch River has been kept alive only because Congress has restored the funds that the Carter administration has cut out of its budget.

GAO said that the Energy Department's assumptions on such variables as the breeder's capital cost "range from doubtful to highly questionable. The direction of this bias is such as to lean toward conclusions that support the administration's previously stated postion—that there is enough time for the United States to delay breeder development."

The GAO report came out strongly for continuation of the Clinch River project—a proposal that can generate an argument even from some who describe themselves as supporters of the breeder-reactor concept. Their argument is not that the Clinch River design is obsolete, as the Carter administration contends. Rather, they say that the U.S. would be better off if it leapfrogged the Clinch River phase and went on directly to build a much larger demonstration breeder.

"If we proceed with Clinch River, by 1988 we'll have a 350-megawatt plant," said Robert Staker of the Energy Department. "That would be 15 years after the French and the Soviets had the same thing. We have to do leapfrogging if we want to maintain our position."

As it happens, that is exactly the administration position. It proposes to drop Clinch River but to proceed with conceptual studies of a 1000-megawatt breeder that could go on line early in the 1990's. A detailed design for such a plant will be completed next year, according to DOE's Staker.

One way or the other, the U.S. must decide about the breeder during this decade. "There is room for conservation in the United States, because your per-capita energy consumption is two and a half times that of France," said Zaleski. "But in four or five years, your energy savings will taper off. Then you will be in the same position as we are. You must go back to energy growth for growth of your economy. The minimum risk for society is to have the nuclear option available. To have the nuclear option, you must have the breeder reactor." PS

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Tomorrow's high-flyers take off in Europe

Coming: more composites, new wing technology, small commuter airliners

By BEN KOCIVAR

HANOVER, W. GERMANY

Looking down 500 feet from my well-upholstered seat in Bell's new 214 ST twin-turbine, 18-passenger executive helicopter, I could see about 100 new planes on the ground. At the chopper's controls was a friend of mine, Maj. Gothelm Kobusch. A seasoned helicopter pilot in the Luftwaffe and a respected aviation journalist, he had teamed up with me before at Paris and Farnborough aerospace shows.

"Not so many fighters and bombers as in the French and English exhibitions," he remarked.

This resulted, in part, from current U.S. government policy, which limits aggressive marketing of our new military hardware. At one time, the U.S. staged spectacular high-performance flight demonstrations with its new planes at international air shows. But the Europeans are not inhibited. For the Hanover show, France and England had their crack air-force aero-

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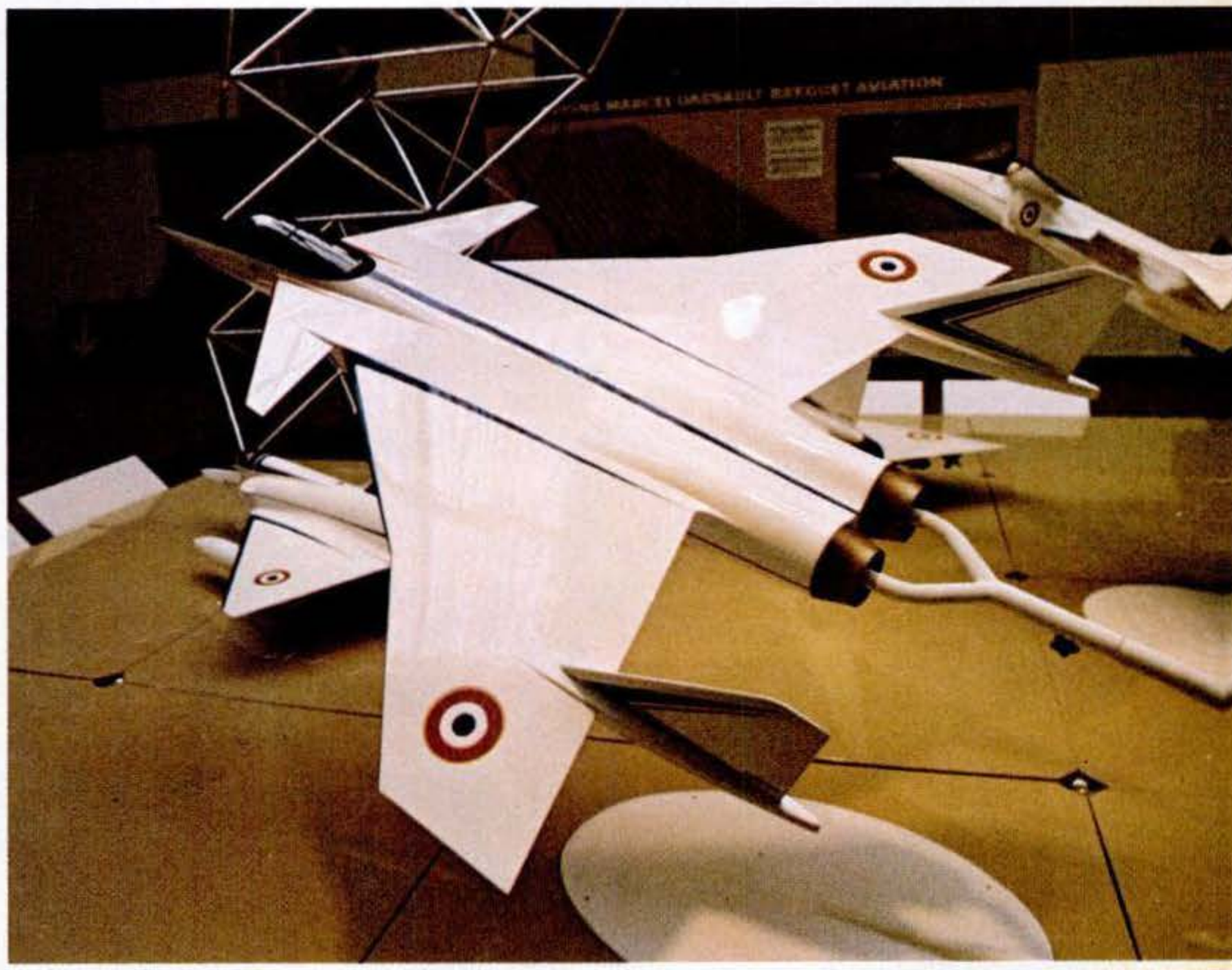

Fighters for the 1990's may use twin-engine modified-delta configuration with large canard wing forward to improve maneuverability. Photo at top shows full-size mock-up of Germany's MBB fighter. Its plans call for extensive use of composites, advanced afterburner engines for greater thrust. France's Dassault-Breguet (above) has unusual rudder fins widely spaced behind the main delta wing.

Twin turboprop small commuter airliner, being jointly developed by Saab of Sweden and Fairchild Industries of the U.S., will carry 30–40 passengers. GE turboshaft engines, originally designed for helicopters, will power it. The plane is scheduled to fly in 1982. Airlines will take delivery of it in '84.

New wing technology that provides high lift with low drag is proposed for STOL airliners. It's shown here on a modified Do28 Skyservant. Dornier plans to build STOL's for 15, 19, and 30 passengers. The company claims that if an engine goes out on takeoff, even on a hot day when the air is thin, the plane can continue climbing on its remaining engine. Range is 1000 miles. First version is due to fly next year.

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Giant amphibian model is examined by author Kocivar. With three turboprop engines, it is an updated version of German military patrol craft used during WWII. Dornier may build it.

High performance is the theme of Gyroflug's Speed Canard prototype. A modified version of Burt Rutan's VariEze [PS, Nov. '78], it will cruise at 220 mph for 1500 miles. Price will be about $38,000.

Sport plane—the Airconcept VOWI 10 Airbuggy—has a 45-hp, two-stroke engine above the pilot's head. Wings are fiberglass. Lateral control is provided by spoilers instead of conventional ailerons. Wings fold back for storage or transport. It's ultra-lightweight, and comes in one- and two-seat versions. Front windshield provides some protection from the wind, but the sides are wide open.

batic teams doing daily formation displays. And the Europeans were hustling their new, hot, multinational swing-wing Tornado fighter/bomber, as well as new military trainers.

Aside from the military planes, an impressive number and variety of executive jets, civilian helicopters, and innovative personal planes from the U.S. and other countries stimulated the interests of well-heeled Europeans. There were also several uniformed officials from the People's Republic of China who got lots of attention.

As these pictures show, innovative designs abounded, many from the growing German aerospace industry. The most expensive new-technology fighters and new airline transports are going to be multinational efforts, with considerable collaboration and funding by France, England, Italy, the Netherlands, and Germany.

Sixteen countries displayed aerospace wares, but notably absent was an exhibit from the Soviet Union, which had been expected to show at least their new small tri-jet airliner, the Yak-42. Poland, the only country from the Communist bloc, was represented by a brace of new choppers and examples of Piper airplanes being made under license there. Poland's state-owned aircraft industry, Pezetel, which normally builds Soviet-designed aircraft, showed for the first time a U.S. design, the twin-engine Piper Seneca equipped with U.S.-designed Franklin engines. Both plane and engines are made in Poland.

The most impressive exhibit was a full-scale mockup fighter from the leading German aerospace company, Messerschmitt-Bolkow-Blohm (MBB). It has twin rudder fins, much like those of the F-18, our newest Navy fighter produced by McDonnell Douglas and Northrup. Called the TKF-90, it is proposed for production by Germany, France, and England. PS

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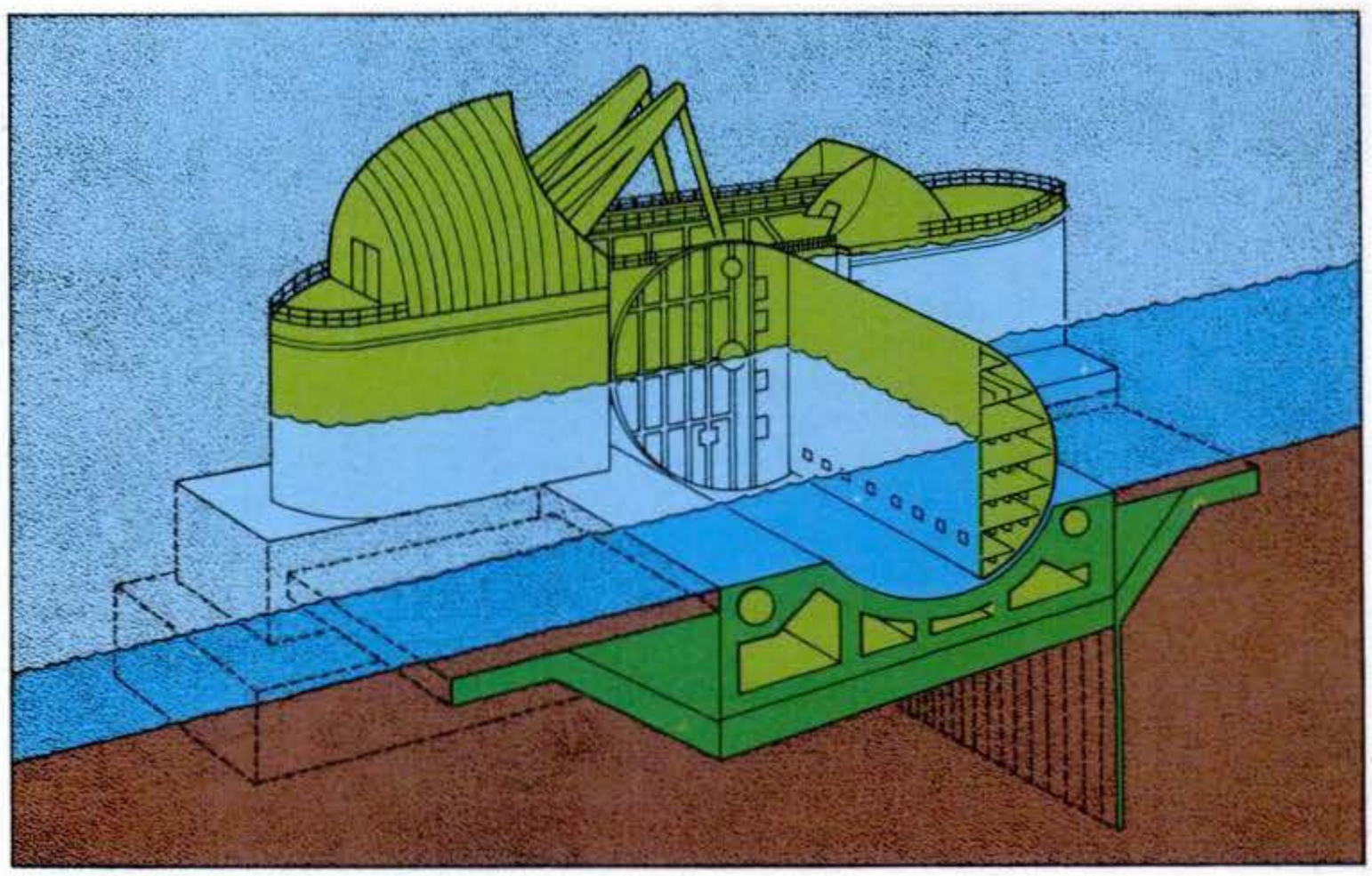
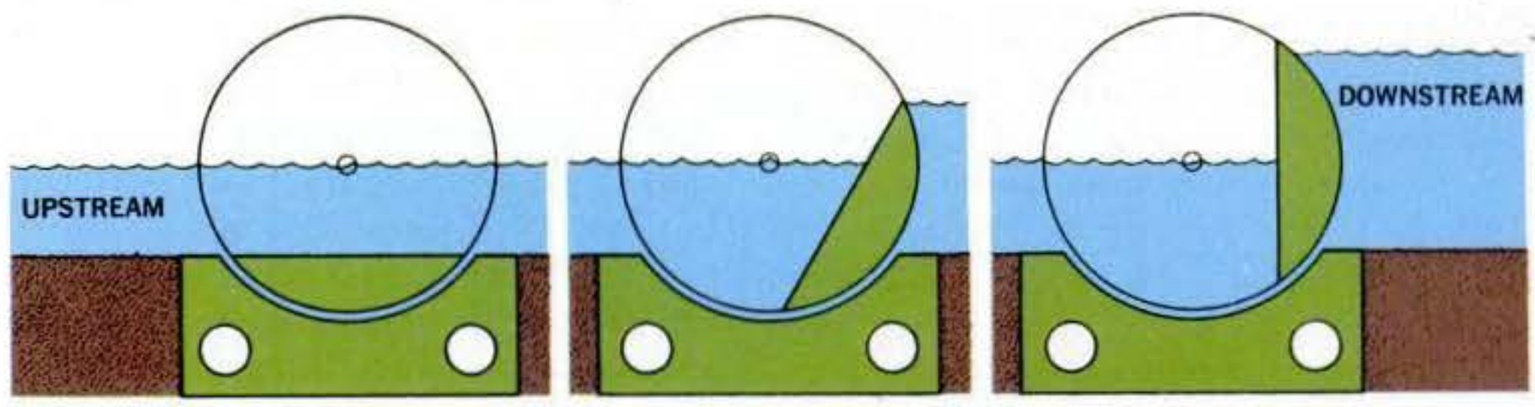
London's ingenious pivoting dam

Model of the River Thames Barrier, as it will look in normal weather, is shown above. Between the concrete piers will be 10 steel gates that can be pivoted into defensive position when a flood tide threatens. The four main gates are in the middle of the river; these lie on the bottom in concrete sills and pivot up to form the dam (diagram, below right). Two similar but smaller gates flank them. Near the river banks are smaller gates (one on the left, three on the right), which will pivot downward.

When a flood tide is predicted, ships will be warned; then hydraulic equipment, housed in concrete piers (diagram, right), will begin to rotate the gates. Time to vertical position: about 30 minutes. When the surge recedes, gates will be returned to their sills and the river's outflow will resume. The Thames River Barrier project is sponsored by the Greater London Council, with grants from various government ministries. Consulting engineers Rendel, Palmer, and Tritton were appointed to design the barrier and supervise its construction. Main civil engineering contractor is the Anglo-Dutch consortium of Costain, Tarmac, Hollandsche Benton Maatschappij B.V.; Davy Cleveland Barrier Consortium is building the steel gates and operating machinery.





GATE IN NORMAL LOWERED POSITION | GATE RISING | GATE IN FLOOD-DEFENSE POSITION

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Massive steel floodgates lie low in normal weather, but rise when a surge tide comes up the Thames

By WILLIAM F. SPANKE

"In the great Palace of Westminster men did row. . ." reads an account of a London flood in 1236. It was probably not the first time the city was inundated, and it certainly wasn't the last. Central London was last flooded in 1928, when 14 people drowned. In 1953, floods along England's east coast and the Thames Estuary took 300 lives. Central London was spared only because retaining walls downstream collapsed, dispersing the waters there. The walls were rebuilt stronger and taller.

Now, a mammoth and ingenious project is under way to protect London from a future watery disaster. Keystone of the new defense system is a dam—but a dam with a difference. This one moves. During normal weather, seven separate concrete piers are all that will be visible above water. Ships can pass between them, and the Thames can flow as usual. Between these piers, lying underwater in concrete sills on the river bed, are huge steel gates, shaped like quartermoons. When a flood threatens, they will rotate from their normal horizontal position to the vertical and form a barrier to stop the onslaught.

The River Thames Flood Barrier, brainchild of London civil engineer Charles Draper, will be the largest movable dam in the world. Bank to bank it will measure 1710 feet—nearly a third of a mile. Each of the four main gates will be 200 feet long, 52 feet high, and weigh 3200 tons. Nearer the river banks, six other gates, weighing up to 900 tons each, will help control the water's flow. The concrete piers will support the gates and house hydraulic machinery.

The threat

The Thames River Barrier will be built at Woolwich, eight miles downstream from London Bridge. That's because the flood threat is not from the Thames herself (she's usually a lamb) but from surge tides that gather force in the North Sea under certain frequently occurring meteorological conditions. An atmospheric low-pressure trough, moving east across the Atlantic, creates a small salt-water hump that moves eastward with the weather cell. When it continues around Scotland and turns south into the North Sea (a fairly common occurrence, especially in the winter), a surge develops as the hump reaches the relatively shallow North Sea, and rises even higher when squeezed by the bottleneck of the English Channel. Finally, it is funneled up the Thames Estuary, growing higher as the river narrows. Strong northerly winds compound the problem, and when high tide coincides with these other phenomena, conditions are extremely precarious around London.

And the threat worsens year by year. London is slowly sinking into the bed of soft clay her Roman founders built on 2000 years ago. In addition, the whole island is tilting. Northwest Scotland is rising and southeast England, including London, is slowly being lowered into the English Channel. Today, tides at London Bridge are more than two feet higher than they were just a century ago.

Saving the view

A more obvious route to flood protection would have been to extend the dikes, walls, and levees along the Thames. This series of defenses was begun in 1897 and improved in 1928, 1930, and 1935. They were last raised, by an average of 18 inches, in 1971. But Londoners cherish their traditional views of the Thames from the Halls of Parliament and other historic points. Adding the six or seven feet deemed necessary to meet today's flood threat would alter the prospect drastically. With the pivoting dam, the view will be kept jolly well the way it is. Downstream of the dam—and well away from London's major historic sites—the dikes will be raised.

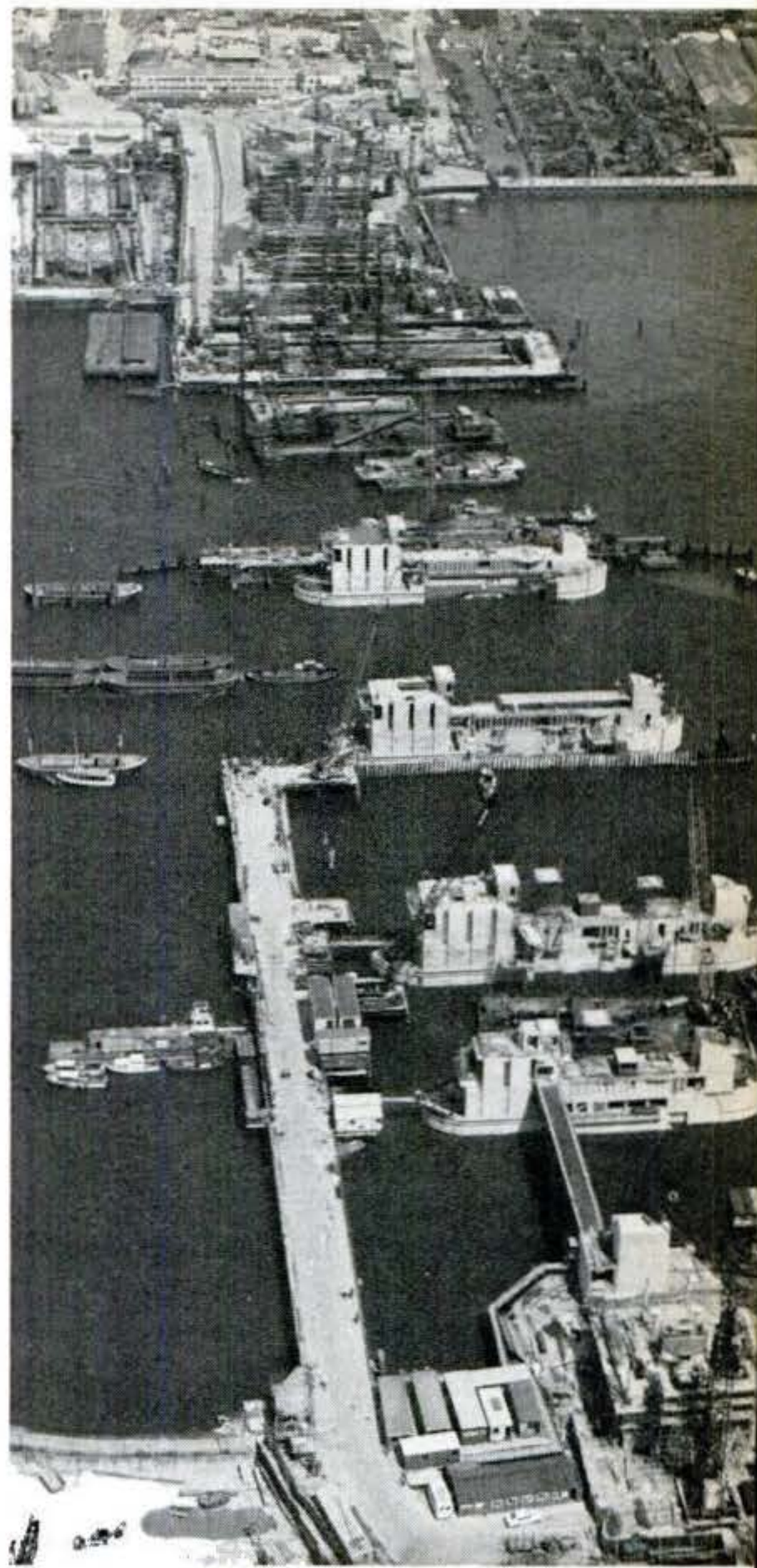
The River Thames Barrier will cost about $860 million; raising the river banks along 12½ miles of dikes downstream will cost an additional $222 million. The total estimate for the project, based on 1979 prices and exchange rates, is $1.092 billion.

Can England's troubled economy afford that kind of expenditure? Some feel the country can't afford to do without such protection. Severe flooding could be a disaster equaling the Great Fire of London, according to project officials. More than a million people could be affected directly. Gas and electric service could be disrupted, scores of telephone exchanges ruined, and transportation could come to a standstill as streets and the underground (subway) were inundated. The underground could be paralyzed for six months. While acknowledging that accurately assessing the cost of a modern flood is impossible, British project officials say, "It would be enormous—easily $7.5 billion, and that would not count human misery and loss of life."

To speed construction of the barrier, shipping has been limited to a single, 200-foot-wide channel—the width of one of the main gates. Original plans called for building the southern half of the dam first while ship traffic used the northern channel, then routing ships to the south side as the northern half was built. But with the altered procedure, construction is proceeding simultaneously on most of the dam. Thus the dam may be operational by December 1982, two years ahead of the expected date.

When the dam is complete, Londoners can relax—for a while. But remember that the city is sinking and tides are getting higher through the years. Some believe that within 50 years a surge tide could top the new barrier.

What's to be done? No one knows. The Thames River Flood Barrier is pushing technology—it simply can't be built bigger. Londoners will just have to keep a stiff upper lip and hope that the next generation of engineers will devise a new plan as ingenious as this one. PS



Work on the River Thames Barrier goes on around the clock. But now the probability of a flood tide higher than existing dikes is about one in 50 in any year.

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Automatic bike transmission

Changing pedal pressure automatically selects the optimum gear ratio for acceleration or climbing

By DAVID SCOTT
DRAWING BY EUGENE THOMPSON

BATH, ENGLAND

"Try the bike on that slope," said Michel Deal, pointing up a steep road in the hilly outskirts of town. It was tough going at first, but as my right leg thrust down, the strain lessened, for now my legs were moving faster. The cycle had automatically shifted to low gear. And it stayed there as I pumped furiously up the hill.

"Now ease off a bit," he shouted after me. As I did, my pedaling slowed, and so did the bike. The gear had shifted to a ratio too high for the climb. To keep up the pace, I had to shift down. To do that, I just pushed harder. On the level road at the top my cranking rate and effort gradually tapered off, but the speed didn't drop. The bike was shifting imperceptibly toward high gear.

Michel Deal, designer of this automatic transmission for bicycles, is a 27-year-old French engineering Ph.D. lecturing on the theory of mechanics at the University of Bath. A racing cyclist, he spent many sleepless nights working out a variable-diameter primary sprocket that would maximize pedaling efficiency. His chain wheel has six small sprockets around the circumference that slide in and out along radial slots, changing the ratio according to pedal effort (see drawing).

The basic idea is not entirely new, but Deal has added a critical ingredient: a means of locking the sprockets at a fixed radial position for any constant pedal pressure. This is essential for a bike, because a human being is a special kind of prime mover.

Unlike a car engine, a bike rider delivers intermittent power that varies cyclically from zero to maximum twice during each revolution of the sprocket wheel. Deal's ingenious system for both ratio control and locking is entirely automatic, and built into the chain wheel. The rear-wheel spring tensioner that takes up chain slack is the only external mechanism in the system.

Ratio changes are made in 16 steps, since such a drive arrangement cannot be continuously variable. That's because the chain wheel naturally shrinks or expands by two teeth at a time to match the pitch length of the chain links. It has 64 effective teeth at maximum diameter, which reduces to 32 teeth for a ratio spread of 2:1. Here we're counting imaginary teeth, for the wheel is in fact hexagonal, not circular. Despite the odd shape, I found that pedaling felt normal, while ratio changes were barely noticeable.

Energy efficiency

The advantages? "Sixteen speeds let you optimize the energy of the cyclist very closely," explains Deal. "With my system, the best ratio for

Sprocket self-adjustment in automatic-chain-wheel prototype is demonstrated by designer Michel Deal. Spring tensioner at rear wheel takes up chain slack.

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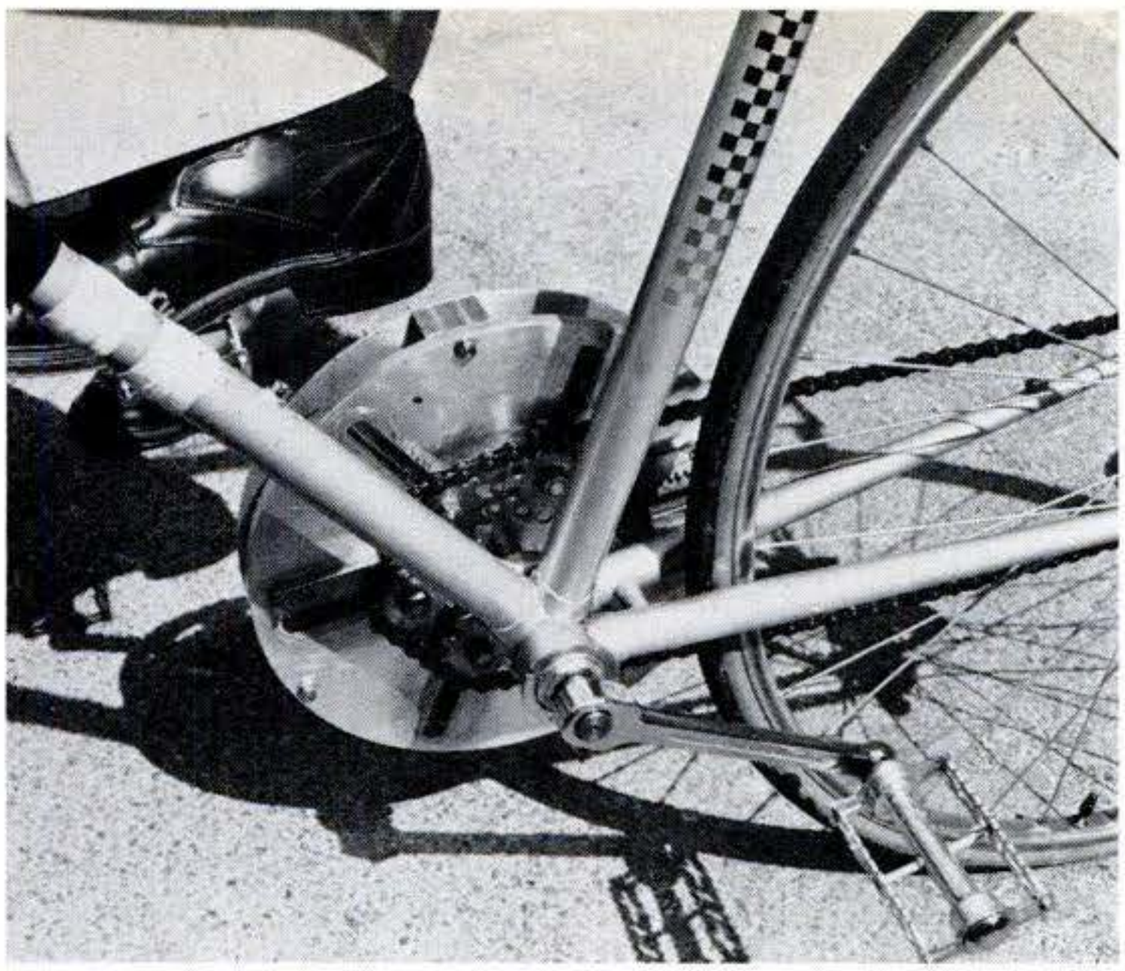


To change gears while standing still, increase pressure on right pedal and sprockets slide into low ratio.

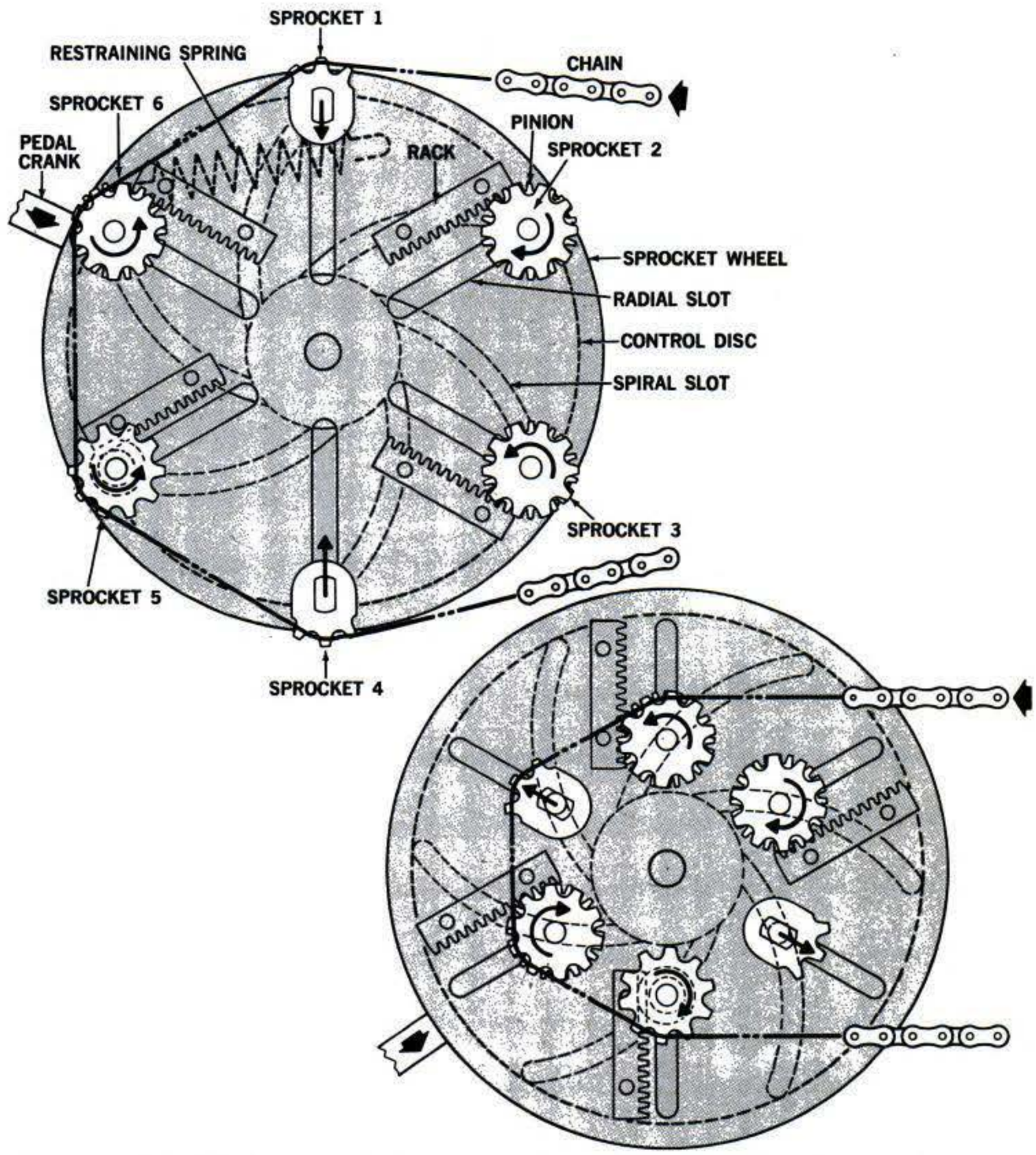
Restraining springs resist relative rotation between sprocket wheel and control disc; they also return disc to high gear.

acceleration and climbing is selected automatically." Deal also claims that his transmission's mechanical efficiency is better than a derailleur's, "where the chain is sometimes misaligned between offset sprockets, increasing frictional losses.

"And mine is a 'hot-shift transmission,'" adds Deal, "which means it changes gears under power. With a derailleur you must lift your foot when the chain shifts between sprockets. In that instant you lose some momentum."

The transmission on the bike I rode is an experimental model machined from solid metal. At eight pounds, it's much too heavy for any lightweight bike. In its present form, reliability is not really a factor: The thick exposed slots and gears of this model would soon be clogged with dirt, and the moving steel parts are not even hardened.

Deal wanted to prove the principle, and he has done that with 200 miles on the road. Now he has improved designs on the drawing board. One has a spoked chain wheel with integral slots that could be stamped from sheet steel, and would be easy to keep clean. An even simpler design eliminates all the slots, gears, and sliding parts. The sprockets swing in and out on pivoted links, with their rotation and radial positions controlled by cables wound around pulley-like hubs. At this time, several European companies are interested in Deal's transmission, and he is confident that the system will make it into production. He figures the weight could be brought down within a pound or so of a derailleur. The cost? In volume production, perhaps the same as a top-quality, conventional 10-speed bicycle, suggests Deal. PS



Six sprockets slide in radial slots to reduce chain's working diameter from 10 inches to five inches. Tips of sprockets fit in spiral slots of separate control disc that's linked to sprocket wheel by restraining springs. Sprockets 1 and 4 are three-tooth sectors that slide on squared spindles and don't turn. Sprockets 2, 3, 5, and 6 turn, but only when sliding. Upper drawing shows top gear; high right-pedal pressure at crank angle shown increases chain tension, forcing sprocket 1 inward. Control disc turns, and movement of spiral slots squeezes other five sprockets inward in unison. If pressure is maintained, chain shrinks to minimum diameter (lower drawing). Low gear is held for all further turns, provided pedal pressure is unchanged. If pressure is eased near end of critical crank sector (lower drawing), sprockets move outward under spring tension. That's because sprockets 3 and 4, with a locking function, are clear of chain.

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Direct-injection diesel

15 percent more fuel-efficient

A substitute for standard auto diesels? Fiat's secret: controlled turbulence swirl

By JAN NORBYE

ORBASSANO, ITALY

Makers of diesel-powered cars all over the world are striving to cut the fuel appetites of their engines. Diesel cars already burn less fuel than cars with gasoline engines. But still further gains can be made. Fiat may have found one way—with a direct-injection diesel.

Today's car diesels have split combustion chambers (with injectors spraying into swirl chambers or prechambers linked to the cylinders by open gas passages). These engines have smooth combustion with relatively low noise and roughness, but with a high price: They burn more fuel than truck diesels, which have direct injection (i.e., the injector nozzles are aimed into the cylinders, usually into a cavity in the piston crown). This insures more efficient combustion and lower fuel consumption than is possible with split combustion chambers.

Many attempts have been made to use direct-injection engines in light vehicles, but so far with poor results. Some years ago International Harvester put a direct-injection diesel into a Scout, and found that the car was being shaken to bits. Diesel car makers are in the situation of knowing the solution, but lacking the method. Now Fiat's method looks promising.

I went to Fiat's research center at Orbassano to see the direct-injection engine and discuss it with its designers and development engineers. Fiat also had a test car (a 131 station wagon) ready for me to try out and judge for myself.

The engine was cold, but it started immediately. Glow plugs are not needed with direct injection. I was surprised at the subdued knock at idle, and opened the hood. The knock abruptly became louder. Heavy layers of acoustic insulation were attached under the hood.

At idle, the engine rocked a little, in what seemed to be an erratic pattern. A push on the accelerator stopped the vibrations. The engine was rock-steady at 1500 rpm.

I got behind the wheel and drove off. I had been told that all I had on tap was 50 hp, so I did not expect the wagon to take off like a dragster. With three people on board, it went from standstill to 60 mph in 30 seconds, which puts it on a

We drive Fiat's experimental hybrid electric car

"What's that noise?" I asked the engineer who was riding with me. "Did I do something wrong?" The car had been going along very quietly at steady speed until I took my foot off

Author Norbye at the controls of the experimental hybrid car. Fiat's main reason for building the prototype is to see where it stands on hybrid theory and hardware.

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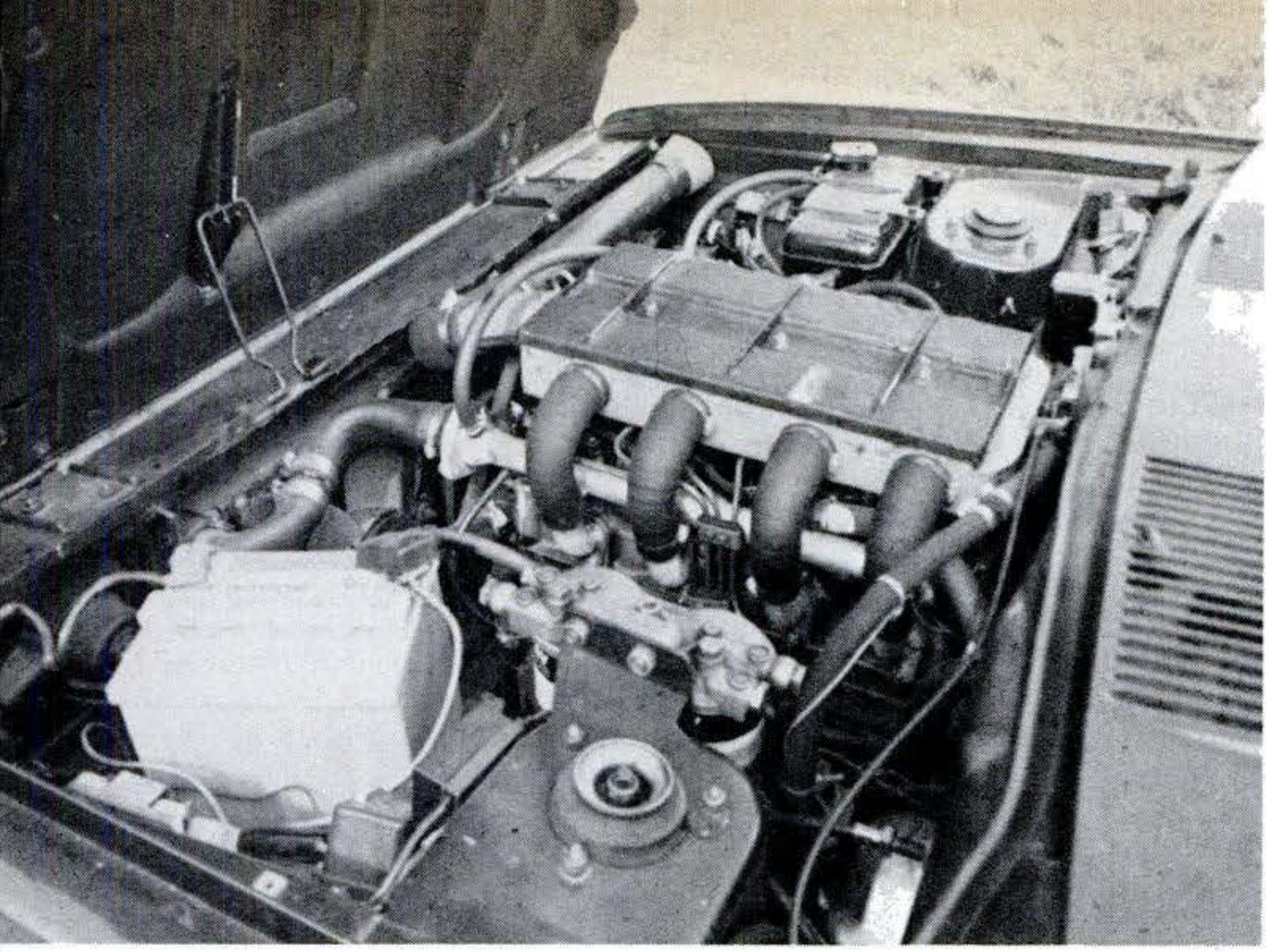

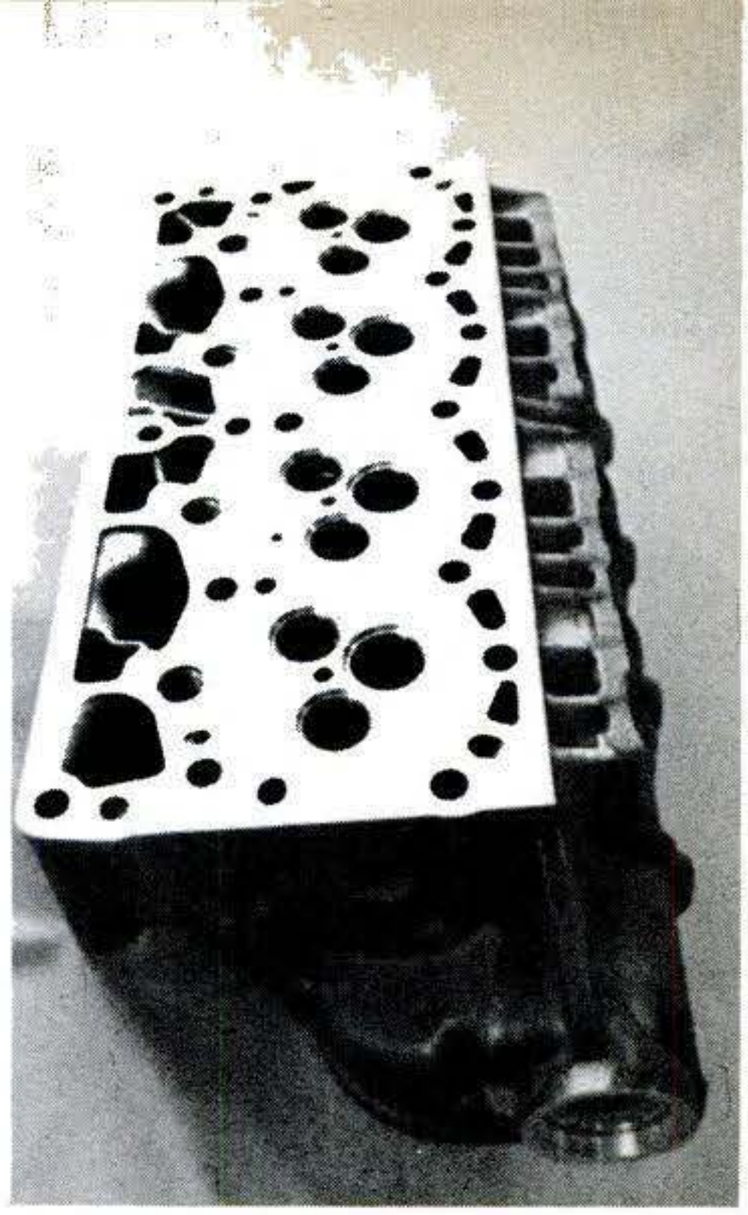

Diesel engine (left) has four intake runners on the left and four on the right. Exhaust manifold is also on the right side. Lower face of cylinder head (above) is machined smooth. Each pair of small holes is for intake valves; bigger hole is for exhaust.

par with the 1956 Mercedes-Benz 180 D or the Peugeot 404 diesel from the mid-1960's.

The experimental Fiat engine has excellent low-end torque, giving a strong pull in second and making third gear suitable for any speed from 15 to 75 mph.

The car is geared for a top speed of 93 mph, and the engine delivers maximum power (50 hp) at 4300 rpm with a compression ratio of 17:1. Maximum torque is 63 ft-lb at 3000 rpm. Displacement is only 1476 cc (90.5 cu. in.), about the same as Volkswagen's production-model four-cylinder diesel (which is also undergoing development as a direct-injection engine).

At the heart of Fiat's direct-injection engine is what amounts to a new combustion system. It works with controlled-turbulence swirl generated by a new principle. It's a little as if you had taken the swirl chamber out of the cylinder head and countersunk it into the piston crown. The flow pattern in the turbulence is created by using two intake valves per cylinder, and is fed from channels entering the head from opposite sides. The port shapes and valve angles promote the desired swirl formation with a double attack, ensuring fast flame-front travel and complete combustion.

This form of double induction also insures better control over the swirl pattern through a wider speed range. A single exhaust valve per cylinder is placed alongside one of the intake ports, and the injector nozzle is mounted vertically on the cylinder axis in the center of the cylinder, aiming its spray into the combustion chamber. The feasibility of this system has been thoroughly established, and the project went into its in-vehicle test stage last year.

The project began under the sponsorship of Italy's National Research Council. The results obtained in Fiat's experiments with this engine are so promising that Fiat now plans to finance its own large-scale development of it. How good is it? Calculations based on actual tests indicate an in-car fuel saving of 15 percent, compared with a swirl-chamber diesel of similar power.

No serious work has yet been done to match injector nozzles or the Bosch distributor-type pump characteristics to

Continued

Battery pack, in trunk here, would occupy less space in future cars.

the accelerator to slow down for a corner. Then a shrill whirring sound filled the car.

"No, that's just the generator," said Riccardo Scalet, Fiat's director of power-train research. "This is our first test car, and we have learned a lot from it. Today, we would do many things differently. For instance, we would go to an electronic generator, which would run silently."

Until that moment, I had not realized how highly experimental this car was. Fiat is not promoting it, but granted my request to come inside the research laboratories and see where the company stands on hybrid-electric-vehicle technology. "We built this car mainly to check the accuracy of our calculations," said Scalet.

The car is a 131 (sold in the U.S. as the Brava). In addition to its four-cylinder gasoline engine, it carries an electric motor mounted behind the torque converter. The 131 offers ample space for all sorts of equipment and instrumentation, but is too big and heavy to give very good performance or fuel economy.

Still, I found the car quite drivable, with a top speed of 75 mph and acceleration times of 20 seconds from standstill to 50 mph and 27 seconds to 60 mph. According to Fiat's test reports, fuel consumption averages 22.8 mpg in all-around driving. Scalet says that figure would be raised above 30 mpg if a car were built today, incorporating the latest technology.

The 903-cc, four-cylinder engine (from a Fiat 127) uses a standard carburetor. It's detuned to deliver 33 hp and is mounted longitudinally in the car. Immediately behind it is a hydraulic torque converter.

Continued

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this engine. Tests are just beginning with a new type of injector that has no internal reservoir.

"Up to now, we have concentrated on the turbulence," says Luigi Conti, who made the fluid-dynamics calculations for the engine.

Riccardo Scalet, a Fiat engineer, feels that the only real problem still facing the engine is air pollution. Carbon monoxide emissions are quite low and well within all limits (including U.S. federal standards), and oxides of nitrogen are in the 1.5–2.0-gram/mile range. But hydrocarbon emissions are still high.

The basic effects of modifying the injection-advance curve have not yet been fully mapped, and, consequently, Fiat does not yet have a measure of the potential for lowering hydrocarbon-emission levels by injection-system adjustments.

Smoke can be controlled

Smoke levels are low throughout, and the Fiat research engineers do not anticipate a big problem in that area. The test car emits more smoke than it should under full load at speed, but a solution may be found in altering the injection curve. "Bigger cylinders would also produce less smoke," says Scalet.

During the research phase, many different piston configurations were tried. Out of these studies came one piston design that has been selected for further development.

The aluminum cylinder head is designed with a flat lower face and has cast-in bearings for a single overhead camshaft, belt-driven from a sprocket on the crankshaft. All valves are operated via rocker arms of varying lengths and input/output ratios, mounted on a single rocker-arm shaft.

Rather than the modern Sofim diesel, which Fiat designed and is producing in collaboration with Renault, the engine block used is taken from one of Fiat's oldest small diesels, type 305 from 1953. It is an in-line, four-cylinder unit with a three-main-bearing crankshaft. Bore was reduced from 82 to 75 mm and the stroke shortened from 90 to 83.5 mm.

The Fiat engine has a stroke-to-bore ratio of 1.113:1, while the Volkswagen, with 76.5-mm bore and 80-mm stroke, comes out at 1.045:1. It is apparent that Fiat's engineers are leaning toward greater emphasis on low-range torque than the German engineers.

The type 305 block was not the ideal starting point for a 1½-liter engine, but the designer, Pierre Bertoldi, chose it for reasons of convenience. For one thing, it is too heavy in relation to its power output, but its extra margin of structural strength is a possible safety factor during the research and development stages. The big block also makes it easier to enlarge the displacement without introducing other changes.

The car chosen for road tests is not the ideal model for this engine, which is underpowered for the Fiat 131 while being too bulky to fit in smaller cars. The turbocharged version will, however, fit nicely in the 131, and should give it the performance of a 2.2-liter (134 cu. in.) unit.

The turbo version is running on the dynamometer right now, and in the words of Riccardo Scalet: "We just cobbled up a test installation with the first turbocharger we could find. It's too large for this engine, but we immediately got a 30 percent power increase. It runs with lower emission and noise levels, and we expect lower specific fuel consumption, too," he adds.

Problems with turbocharging

However, Scalet voiced some doubt that turbocharging is the best solution: There is the energy loss in using the waste gate to balance the overall compression between turbocharger and cylinders, and the acceleration lag in the turbocharger response at low speed can be a problem.

"We are looking at different ways to compress air," says Scalet. The first alternative he cites is the BBC Comprex pressure-wave supercharger. Volkswagen, as I have reported earlier, has a Roots-type positive-displacement blower on some of its advanced experimental diesel engines.

According to Scalet, Fiat is also working on an electronic fuel-control system for the diesel. It may be the only solution for effective emission control, but if standards can be met without it, the electronic control system will be evaluated strictly on the basis of its cost/benefit ratio.

Work such as Fiat's shows that the auto diesel engine is still in its infancy. When the research phase is completed, Fiat plans to design a prototype incorporating the fruits of everything that has been learned, and develop that toward eventual production. How soon? No earlier than 1985, and probably no later than 1987. PS

Hybrid electric

"A torque converter alone, without reduction gearing, is not the best solution," says Scalet, "for it forces the converter to operate in abnormal slip conditions, where it is least efficient. Today, we would install a Transmatic controlled by a microcomputer." The Transmatic is an all-mechanical, continuously variable drive with a metal chain running between variable-width double-cone pulleys.

The engine is started with a normal key, and a small switch on the console controls the drive. It has three positions: forward, neutral, and reverse. Idle speed is about 900 rpm, and there's no creep at idle. Stepping lightly on the accelerator produces only hesitant motion in the car. Firm pressure to half-open position makes the car move off gently, using only the power of the heat engine. Full throttle brings in the battery power, and maximum acceleration.

Electric power boost

An electric motor is mounted behind the torque converter and centered on the propeller shaft. It acts as a generator when not running on battery power. The DC motor is rated at 24 kilowatts and 144 volts. The batteries provide 250 amps. Braking effect from regeneration is similar to shifting down one gear, and braking current is 50 amps.

Basically, the gasoline engine provides the power, except upon heavy load demand when the electric motor kicks in, assisting the engine. The mechanics of this are more expensive and complex than some other ways of powering a hybrid car, says Scalet. But, he claims, under part-load operation, energy losses are only three to five percent, as opposed to 20–30 percent with the type of system in which the engine runs only a generator, which, in turn, runs an electric motor and charges the batteries whenever surplus energy is produced.

A 386-pound battery pack is in the forward part of the trunk. The standard fuel tank remains, but the spare wheel is moved to a slanted position farther back. There's not much space left with the batteries and spare tire in place. In a production car, more space for carrying things would be provided.

The hybrid-electric 131 weighs 882 pounds more than the production model. With nickel-cadmium batteries and an optimized electrical power train, the difference could be cut in half, Scalet says.— *Jan P. Norbye*

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Popular Science

Home electronics

SPECIAL SECTION

Home electronics: currents for the '80's

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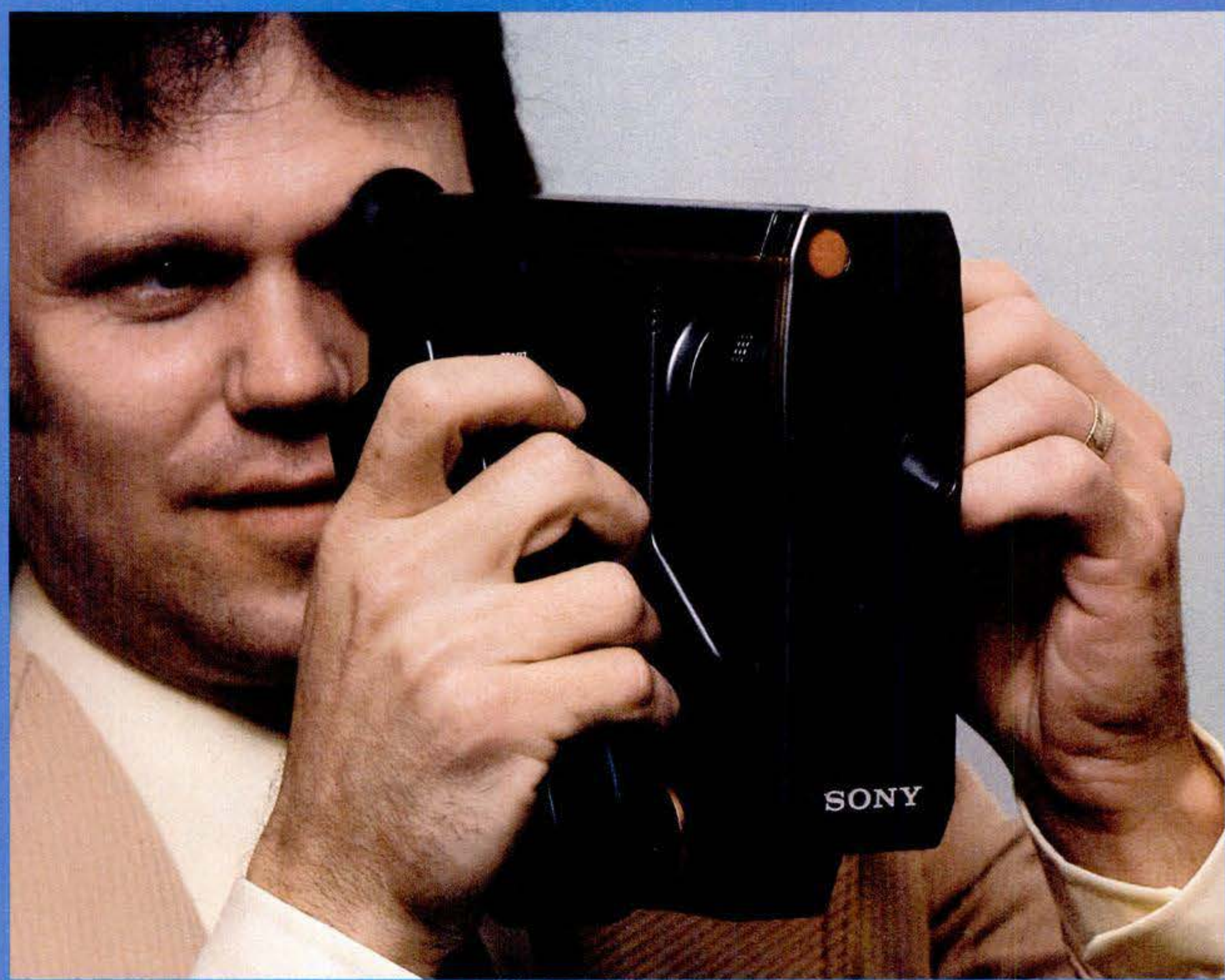

Future video: Sony's remarkable camera/recorder

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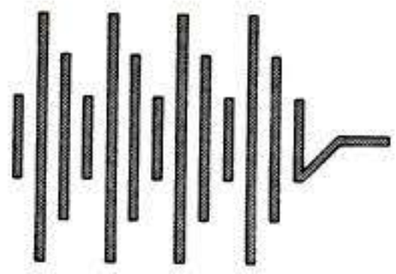

Home electronics: Currents for the 80's

By ARTHUR FISHER

What kind of entertainment and information devices will you be watching, auditing, sensing, or Lord-knows-what-ing by the end of this decade? Will your living room be a cockpit for competing themes from, say, *Brave New World* and *1984*, with Big Brother leering down at you from a giant wall screen while you indulge in the feelies?

I don't know, nor does anyone else, for sure. The pace of modern technology and the vagaries of human behavior combine to make long-range prediction a gamble.

Nevertheless, it's fun to guess. To help, I enlisted experts in the electronics industry, in government, and on our own staff—namely John Free and Bill Hawkins, whose articles on current developments follow this essay.

In a way, the less overwhelming aspects of home-entertainment electronics are easier to forecast with some assurance. You will, for example, be able to get stereo sound from your TV set, perhaps in 1982, and AM stereo in your car. Digital audio will probably make an impact by 1985. You'll be able to keep the kids from watching "R"-rated shows on cable TV by means of a special coding system that can be bypassed, if you know the password, after they are in bed. And whatever equipment you possess, it will be controlled remotely, perhaps by voice.

But the beginnings of really sweeping changes are already visible. They are arriving on the first shock waves of the explosion of material available, via video, audio, and computer, for both entertainment and useful services. In television, we are entering what a recent SRI report called a fourth phase, that of viewer-controlled TV, "which may very well have as much effect on television as freeways have had on the ownership and use of motor vehicles." The viewer control will stem from two sources: the ability to time-shift (record for future viewing by means of video-tape recorders and perhaps video-disc recorders); and a cornucopia of varied programming and services.

Dr. James Vollmer, a vice-president of RCA, predicts that home TV will provide as many as 25 different services, from entertainment to two-way communication, security, financial management, library functions, and much more. Says Jack Wayman, senior vice-president of the Consumer Electronics Group of the Electronic Industries Assn., "The 80's will be the video era, because the consumer will be an active participant in TV." And according to Thomas G. Krattenmaker, co-director of the Federal Communication Commission's Network Inquiry, "The average viewer in America is going to have a significantly larger number of choices available. Ten years ago, he had the choice of buying a TV set, but that was it. Now everyone has the option of buying a VCR, and soon a video-disc machine. By 1989, everyone will be able to hook up to a cable-TV system."

The most obvious sign of TV ferment is the proliferation of video-cassette recorders—VCR's. According to the FCC, at the end of 1979 VCR's were being used in 1.2 million American homes—about 1.5 percent. By 1984, the FCC projects, the number will rise to somewhere between 5.5 and 6.8 million homes, with sales leveling off at about one million per year. Unfortunately, an FCC report notes, the presence of incompatible tape systems for VCR's

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has created "confusion that keeps potential buyers out of the market." And the situation will probably get worse before it gets better, making the late, unlamented war of the record speeds look like a pillow fight. Add to the present VHS and Beta formats a new, miniature tape cassette from Technicolor and eventually a different format from N. V. Philips (see the article on VCR's in this issue). And both Sony and Kodak are reportedly working on portable, single-unit video color camera/video-tape recorder outfits that would introduce still other, incompatible formats.

Why Kodak? Such an all-in-one system, with a "filming" time of 30 minutes and instant playback on a small, electronic built-in viewer, would be very attractive to the serious movie maker, who now uses 50-foot reels of super 8 film, each lasting only about three minutes. "I'm surprised that more people aren't making their own movies on video tape," says Elliot Maxwell, acting deputy chief scientist of the FCC's Office of Science and Technology. "The technology is so simple."

The video-disc player, with prerecorded films and other programming at a much lower price, has only just begun to appear. Yet, the FCC projects, "disc player sales are expected to surpass VCR sales within five years." Regrettably, the disc player outlook is also confounded by a variety of competing, incompatible systems [PS, July '80].

Playing back prerecorded entertainment or instructional material, favorite programs you tape from your own set, or, for that matter, home movies—these are some of the ways to expand your television horizons. But many more are on the way. These are the varied information services that either broadcast directly to a specially modified TV set, or rely on cable or telephone links to a computer terminal (or a stand-alone home computer) connected to a TV set. They can provide an enormous range of information: news, weather, traffic reports, sports results, stock prices, transportation timetables, classified ads, supermarket prices, the contents of whole telephone directories, dictionaries, atlases, and encyclopedias—even advice to the lovelorn. Pioneered in England and France [PS, May '78] under such names as Viewdata, Teletext, Ceefax, Oracle, Prestel, and Antiope, some of the systems are now being introduced in the U.S., although usually on a limited or experimental basis.

The simplest of these systems goes by the generic name of teletext. The information is encoded on an unused part of the signal and broadcast along with regular TV programming. A decoder built into the set allows the viewer to call up any of about 800 pages of material at will.

Teletext is coming . . . soon. It will certainly revolutionize the manufacture of TV sets in this country. A task force of the Electronics Industry Assn. has been convened, at the request of the FCC, to choose between British and French systems preparatory to setting up uniform standards for teletext transmission.

At the other end of the spectrum reign all those wonderful things you can do by tying your home computer to one of the commercially available data banks, with their enormous pools of information. (See the story on "Info Banks" in this issue.) Experts predict that one out of every four homes in the U.S. will have a personal computer by 1985. Expressing his own opinion, Mike Marcus, chief of the Technical Planning Staff of the FCC's Office of Science and Technology, said this: "Why would people spend $200 or $300 to get Viewdata, when for $500 they could have a home computer and plug into something like the Source?"

One possible reason—fewer complicated tasks to learn. But the allure of the flexible and powerful home computer is strong. Witness the story of a Washington, D.C., restaurant called The Planet, which caters to news people (shades of Clark Kent). To stir up more business, The Planet installed a number of computer terminals. But, manager Lokesh Singh told me, they were too popular. "People would get very angry when other customers hogged the computers for too long. There was so much friction we had to take them out."

What about the display medium itself—the TV set? Consumer pressure, according to FCC's Maxwell, will compel both broadcasters and set makers to improve performance in terms of noise, picture quality, sound quality, and immunity to interference. Projection TV? Maybe it will boom if someone can come up with a way to produce high-quality sets for less than $2000 or so—not a prospect I'd be willing to bet on. Flat-screen TV? Bill Hawkins fumes: "All my sources say they're working on it, and in another 10 years we should have it. Of course, that's the same number I got 10 years ago." Jack Wayman believes the technology has been developed by a number of makers, but cannot yet be marketed at a reasonable price.

Have I left anything out? Naturally, including some things unimaginable as of now. As Tom Krattenmaker says: "The history of communications has been that the technology is always overwhelming us." PS

"Communications—the technology is always overwhelming us"

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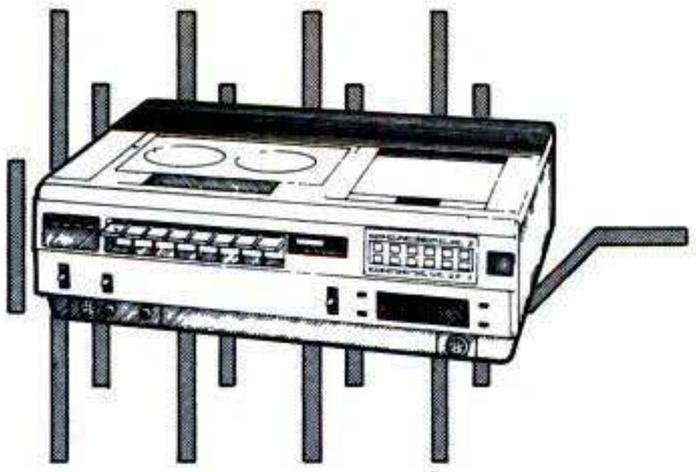

New-generation VCR's

—smaller, lighter portables, feature-packed home decks

Microcomputer flexibility, soft-touch controls, stereo, and more—all for '81

By JOHN FREE
PHOTOS BY JOHN KEATING

New table-model VCR's on dealer's shelves this fall are slimmer, with distinctive, ultramodern styling. And what's inside these new-generation video-cassette recorders—microcomputers for programming and switching logic, all-electronic tuners, soft-touch controls, new TV microcircuits—not only trims away VCR pounds and inches to make the new look possible, it also means more reliability and operating flexibility. Competition is bringing last year's high-end features, such as high-speed picture search and slow-speed and frame-by-frame advance, to under-$1000 models.

These technology advances and features appear in portables, too. Manufacturers have whittled about four pounds off some earlier battery models. Now, with an 11-pound portable and lightweight camera, you can tape on the go without straining under heavy gear. One new portable has a home-VCR first: stereo capability that adds an exciting new audio dimension.

The new lightweight portables, in

Continued

New breed of portable and home VCR decks—sprinkled with recent MCA movie cassettes—includes (clockwise from top) the Sharp VC-6800, RCA VET250, JVC HR-6700U, Quasar VA-520SE (an optional tuner) and its companion deck, the portable VH5300, Panasonic PV-1400, and Sony SL-5600.

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the popular VHS tape format, helped squelch or postpone the expected introductions of two incompatible decks—so-called longitudinal recorders with fixed instead of spinning tape heads. Instead, only one new tape format has appeared, used in a remarkably compact seven-pound portable.

Speed wars

VCR makers are now trying to capture sales by supplying more features at a better price. But until recently, the marketing emphasis was on recording time: *"Our models put more programming on a single tape than theirs."* Sony's first Betamax, which I tried in the PS test lab five years ago, recorded just one hour.

Since then, with intense competition between the VHS and Beta tape formats, manufacturers have steadily boosted recording/playback time by slowing down tape speed (see "How to put six hours on a two-hour cassette," page 94). Machines for both formats can now record the longest movie or football game, so it's a standoff. But judging from the new models I've been trying and others I saw at demonstrations, there's a new kind of speed race—for the fastest picture search.

The first speed-play model I tried was JVC's HR-3600 [PS, Feb. '79]. It doubles tape playback speed so you can bypass commercials, visually find a section faster, or actually watch programs in half the time. (A digital circuit prevents Donald-Duck-like pitch changes from doubled audio speed.)

Some of the newer decks have pulled out all the stops on playback speed for picture search. Sony's SL-5800 with BetaScan, for example, can boost tape speed from five to 20 times normal—in forward or reverse—to pinpoint a sequence or zip through commercials. Toshiba's SuperScan in its V-8000 Beta-format deck periodically displays pictures as tape whips by at 40 times normal speed. Audio, of course, is muted at these high speeds.

The VHS decks, which load and scan tape differently than Beta-format models do, were initially left behind in the high-speed picture-search race. While catching up, VHS deck makers have stressed the slow-motion, freeze-frame, and frame-by-frame advance features of their machines. RCA's lead 1981 VHS model, the VET250 (suggested list price of $995), now has a forward or reverse picture-search feature at nine times normal speed.

Smart decks

Since microcomputers have crept into your new car, the food processor in your kitchen, and practically everything else, you'd expect to see them in VCR decks, too. In the 1981 models, the computer-on-a-chip handles everything from switching logic (pushing the wrong button won't harm anything) to the complex programming tasks of turning decks on and off automatically, to changing channels over a two-week period while you're away.

While microcomputers can increase the flexibility of complex equipment such as VCR's, they can also make deck operation more difficult. On its VC-6800, Sharp has a calculator-like keyboard for computer programming and an LCD panel that shows channels, dates, times, or even serves as a four-digit electronic tape counter.

For each channel you want to program in advance, you have to push some 18-odd buttons in an exact sequence. The panel and keys are also used in a complex procedure to fine-tune channels and assign them numbers. While the 6800's computer aids these tasks, its use demands patience and a knack for nimble, careful keyboard programming.

Sharp's 6800 can be programmed to change channels seven times up to one week ahead. This number-of-programs-days-ahead sequence varies widely among the costlier programmables. What makes this advance programming possible is the all-electronic (nonmechanical) tuners in virtually all new VCR's. Another nice feature is the soft-touch front-panel controls, which operate solenoids to quietly start or stop mechanical sequences.

Picture quality

What about recorded picture quality? Comparing brands, it's very difficult to detect any significant differences. Even in the six-hour VHS mode, where special noise-reduction and enhancement circuits are used, pictures are surprisingly good. Using test patterns, I noted that resolution was slightly worse with Quasar's lightweight VH5300 portable compared with more massive table-top models.

If you have one of the newer color-TV sets with picture-enhancement (comb-filter) circuits, the circuits will only help in reducing picture interference, such as the "rainbox" effect visible on narrow-striped clothing, when playing back recorded programs. That's because, while the comb filters can deliver some 330 lines of picture detail (horizontal resolution) from off-the-air programs compared with 260 or less in conventional sets, most VCR's only play back signals with about 240 lines. As receivers with better picture resolution become more widespread, VCR makers may enhance the picture output from decks.

"Consumers in the '80's will find a world of use for video and won't want

Continued

Hollywood hurries to put movies on video tape

MCA . . . Columbia . . . Paramount . . . Warner . . . Metro-Goldwyn-Mayer . . . Twentieth Century-Fox.

At times, from the names on exhibit booths, I felt it was a Hollywood convention instead of the annual summer Consumer Electronics Show in Chicago.

The new Hollywood names at the show confirmed that virtually all major motion-picture companies hope to benefit from the sales boom in VCR hardware and software (prerecorded tape). Until this year, distributor booths for adult or X-rated video cassettes dominated the video-tape scene at the show. (Studies indicate that while the sales volume of video pornography remains high, its percentage of total cassette sales is falling steadily.)

Why the new interest in prerecorded-cassette marketing? Hollywood companies and others have noted that VCR-deck sales are climbing steadily to the point where two million will be whirring in homes. If even a small percentage of this home-entertainment market buys its Hollywood favorites on prerecorded cassettes at $50 to $100 each, that spells big profits on anyone's calculator.

Paralleling the explosion of new titles is the steady growth of new distributors and retailers. Stores specializing in video cassettes are popping up in larger cities. Mail-order video-tape clubs are multiplying, too. Some tape stores and nationwide chains such as Fotomat rent video cassettes. Pamphlets I collected at the show indicate there are distributors that specialize in everything from special-interest software, such as *The Two Best World Series Ever,* to such Saturday-afternoon TV staples as *Fort Apache* or classics such as *Citizen Kane.* One way to locate new sources of video software is to pick up some of the new video magazines.

Perhaps first prize for innovation in VCR-software distribution should go to a Santa Rosa, Calif., cable-TV firm. It plans to send prerecorded software to customers overnight on blank channels. A computerized controller to switch a subscriber's VCR on and off automatically is planned.

One development that may trim prerecorded cassette prices is the high-speed duplicator. Next year, Japan's Matsushita plans to offer a machine that can spew out 12 two- or four-hour VHS cassettes in four minutes. Conventional duplication techniques work on a "real-time" basis, with a master recorder and numerous slave duplication machines.

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Flip cards fit over buttons to aid programming microcomputer in Sharp's VC-6800. LED's on the deck's tape-remaining selector (left) light up so you can tell if there's enough left to finish recording a program.

to be limited by a stationary system to just taping and viewing TV programs at home," says Charles Phillips, executive vice-president for Akai America. That's the logic behind Akai's entry into the VHS portable market last year and its improved model this year. Portables are capturing a larger portion of VCR sales.

With a portable, of course, you aren't limited just to battery operation outside. All of the portables can be used with an optional tuner. A portable/tuner system works just like an AC-only, table-top model. The combination of deck and tuner costs about $1500, which may prove less expensive than buying an AC-only model and deciding later that you need a portable, too.

Versatile portables

Akai's initial VHS portable could capture only two hours of material on a cassette. Its upgraded model, the VP-7350, includes a switch for six-hour recording. The 15-pound portable also can record audio in stereo. You can record rock or classical stereo concerts broadcast simultaneously over local FM and TV stations. Now you can also tape pictures on the go with binaural audio, which adds an exciting 3D-like presence to sound played back through headphones. (Sennheiser introduced binaural microphones several years ago.)

The Dolby noise-reduction circuits in the 7350 provide a listenable 51-dB signal-to-noise ratio. Akai's 7350 has another unusual feature: a key lock to prevent unauthorized use at a business, or at home by children.

Another new entry in the portable field is the two/four/six-hour VHS 7500 model from Hitachi. It weighs in at 15.4 pounds with its battery (compared with another VHS lightweight, Quasar's 5300, and the identical Panasonic PV-3000, which weigh 13.4 pounds with batteries). To help shrink the 7500's size, Hitachi used specially designed large-scale-integration (LSI) microcircuits.

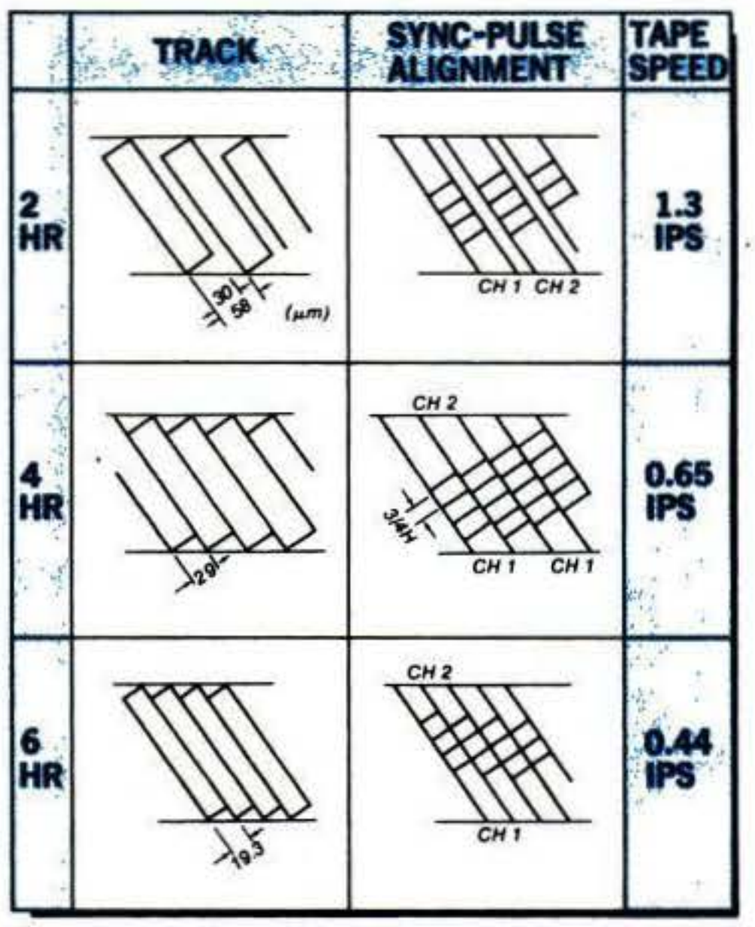
The prize for compactness, however, goes to Technicolor's seven-pound portable, which uses a new (nonstandard) ¼-inch tape—half as wide as VHS and Beta tape. "It is the first step toward a

How to put six hours on a two-hour cassette

Many new VCR's now have a switch that reduces the tape-recording speed enough to put six hours of material on a VHS cassette originally designed for two-hour recordings. (Beta-type decks also have an extra-slow speed for up to five hours of recording.)

Several changes have been made in components and circuits to achieve the extra-long play. The chart (right) shows how some parameters change at various speeds in RCA's Matsushita-built VHS machines. The horizontal segments represent ½-inch tape with diagonal recorded tracks. Adjacent tracks (CH1, CH2) represent a single 1/30-second TV picture frame, and are recorded or played back by heads on opposite sides of a spinning drum. (Some new special-effect VHS decks have a second pair of heads offset 90 degrees from the other pair, and some JVC decks use four heads.)

Matsushita's six-hour decks without special effects have narrower heads (30 microns, or μm) compared with older two/four-hour VHS machines, which have heads 38 microns wide. As playing time is extended by reducing tape speed, the space between recorded tracks is reduced and even overlaps and erases parts of previously recorded tracks. Signals for adjacent tracks are altered before they're recorded to minimize interference between adjacent signals. The sync pulses separating the 262-odd TV-picture lines on each track, for example, are aligned on adjacent tracks in the two/six-hour modes, minimizing the effect of slight mistracking since adjacent tracks have similar picture content. In the four-hour mode, sync pulses can't be aligned, so they're offset slightly (¾H). This precise offset causes adjacent interfering signals to cancel each other optically on the screen.



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more comprehensive and versatile group of video products than would have been possible with former technology," said Jack Minor, president of the firm's audio-visual division.

The new portable deck was jointly developed by Funai Electric Trading Co. in Japan and Technicolor. "Funai will manufacture the VCR, forerunner of other related products in the video field," Minor said. "These will include a Technicolor camera and other innovative items to complement the VCR." The additional hardware may be available by the time you read this. Although the deck can use some portable cameras already on the market, special patch cables are needed for each camera.

The portable's battery supplies enough energy for 40 minutes of taping with a camera, and recharges in one hour. The recorder has a freeze-frame capability, slow and fast viewing speeds. Technicolor plans to market its new lightweight through video, camera, and other retail stores.

LVR's and more

Technicolor's marketing plans for its portable, and the latest 11-pound VHS portables from Japan, were bad news for BASF. BASF had started a new factory in California to manufacture its longitudinal video recorder (LVR), which it has been demonstrating at European shows for several years. But the factory has now been closed down, and an 11-pound LVR model from BASF expected at the summer Consumer Electronics Show never appeared.

LVR machines use a fixed head, like audio tape recorders, with the tape pulled at high speed over the head. So-called helical-scan decks now on the market spin the video heads at high speed, but move the tape very slowly. While an 11-pound LVR model sounded impressive a few years ago, helical-scan technology has caught up with it. Toshiba also demonstrated a slightly different LVR model last year. While it is planning to market an industrial version of its LVR, the consumer model expected was delayed this year, too. The LVR tape format is temporarily postponed, but its simple-construction and lower-cost advantages will no doubt surface again, probably in the form of advanced super-compact VCR decks.

Although the VHS and Beta formats seem firmly established, at least one other new tape format is on the way. Next year, N.V. Philips may introduce its eight-hour VCR in the U.S. through its Magnavox subsidiary. This high-technology VCR uses a nonstandard cassette that records four hours on one tape side; it is then turned over like an audio cassette for four additional hours.

Sony leads the recording-time battle with a cassette-changer mechanism for its decks that provides a 20-hour capability. But Philips reportedly has a changer for its deck that permits 48 hours of recording and playback. The recording-time war may start again in 1981. PS

A sample of new-generation VCR's

Manufacturer	Model	Price($)	Format, hrs.	Programmability	Freeze frame	Weight (lbs.)	Size (in.)	Comments
JVC	HR-6700U	1350	VHS 2/6	6 programs, 7 days	Yes	31	18½×5 13/16 ×13¾	Variable-speed slow motion. Double/triple-speed playback
Panasonic	PV-1400	1295	VHS 2/4/6	8 programs, 14 days	No	28	19×6×14	Nine-times-normal-speed picture search. Auto rewind at end of tape
Quasar	VH5300 portable deck	1150	VHS 2/4/6	—	Yes	11	11⅜×4⅜ ×9⅝	Slow motion and frame-by-frame playback in 6-hr. mode. 1-hr. battery life
	VA520SE tuner/pwr. supply	350	—	8 programs, 14 days	—	10	11 7/16×4⅜ ×9 11/16	Built-in power supply runs 5300 and charges its battery
RCA	VET250	995	VHS 2/4/6	1 program, 1 day	Yes	27	19×5⅜ ×14	Nine-times-normal-speed search in 4/6-hr. modes. Preset auto stop
Sharp	VC-6800	1295	VHS 2/6	7 programs, 7 days	No	40	19⅛×6⅝ ×15⅞	Auto program locator counts cue signals in fast forward
Sony	SL-5600	1350	Beta 2/3/4.5/5	4 programs, 14 days	Yes	36	19½×6½ ×14⅞	Triple-speed picture search

MANUFACTURERS' ADDRESSES

JVC America Co., 58-75 Queens Midtown Expressway, Maspeth NY 11378; **Panasonic**, One Panasonic Way, Secaucus NJ 07094; **Quasar Electronics Co.**, 9401 W. Grand Ave., Franklin Park IL 60131; **RCA Consumer Electronics**, 600 N. Sherman Dr., Indianapolis IN 46201; **Sharp Electronics Corp.**, 10 Keystone Pl., Paramus NJ 07652; **Sony Corp. of America**, 9 West 57th St., New York NY 10019.

Other firms offering VHS decks are: Curtis Mathes, General Electric, GTE Sylvania, Hitachi, Magnavox, Mitsubishi/MGA, J. C. Penney, Philco. Other Beta-format firms: Sanyo, Sears Roebuck, Toshiba, Zenith. Technicolor Audio Visual's address is 299 Kalmus Dr., Costa Mesa CA 92626.

Compact portable VCR introduced by Technicolor uses a ¼-inch-wide tape in small (nonstandard) cassettes. The seven-pound deck records 30 minutes on a cassette. AC adapter (right) contains RF modulator that feeds signals to TV.

Remote controls for newer decks handle more and more functions. Slider control for JVC's HR-6700U varies playback speed, while another button freezes TV picture. RCA's VET250 control has a button to change channels.

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Lightweight, low-cost cameras put "movies" on tape for instant replay

By WILLIAM J. HAWKINS

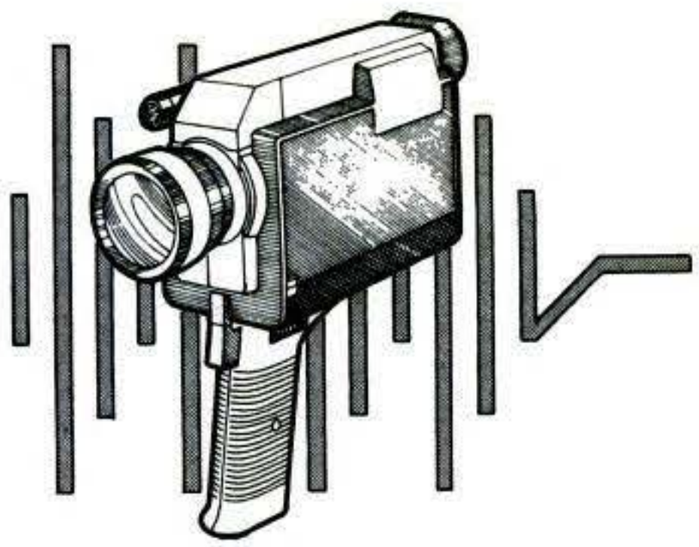
My oldest daughter was to be in a school play. Perfect, I thought, for a video taping.

With the J. C. Penney system I was using, I could tape the entire hour-long show on one $13 video cassette. Not bad, considering that an hour's worth of film and processing for my super 8 movie outfit would have cost me about $150.

It's now all possible because of a new group of lower-priced home video cameras. Sure, color video cameras have been around for years, but at prices ranging up to $50,000, they were a little out of reach for amateurs. New home cameras may be a step down in size and video quality, but they are affordable—from $750 to about $1500. And even those prices are dramatically offset when you consider the cost of film versus tape. That doesn't include the cost of the video-tape recorder you'll need, but it's not like a projector that sits in the closet for months at a time. You can use it to tape TV shows.

Video cameras take an image and convert it to a color video signal that can be recorded on any video-tape recorder. Since there's no film involved, there's no processing. You get an instant playback right on your TV set. Made a mistake? No problem. Just rewind the tape—as you would on an audio recorder—and try again. Record the same scene over again as many times as you like using the same tape. There's no waste and recording time is limited only by your recorder—up to six hours per cassette on some machines (see "New Generation of VCR's," this issue).

Choosing a video camera, however, is not as easy as using one. Price is one consideration, of course, but nearly all makers offer cameras at competitive prices. Picking the right one depends largely on how you'll use it, the features you'd like, and what equipment—if any—you already own. Here's how you sort through the variety of models available.



Just a camera

Despite their sophistication, video cameras rely heavily on conventional camera optics. Instead of focusing an image on a strip of film, however, the lenses on these cameras focus light on the face of an internal vidicon tube that converts the image to electronic signals.

The lens used will have an effect on the type of recording you can make. Low-cost models, for instance, usually have a single-focal-length, 25-mm, f/2 lens. It's a standard lens with good quality, but it is limited—it has no wide-angle or telephoto capabilities.

The "f" number is a measurement of the "speed" of the lens—how much light it can gather. The lower the number, the larger its maximum aperture and the more light on the vidicon tube. An f/1.4 lens, for example, will provide twice the amount of light of an f/2. This means little if you do most of your shooting outdoors in sunlight. But as the light level goes down—say, if you move indoors—an f/2 camera will require additional floodlighting sooner than the 1.4.

Although more expensive cameras do have larger apertures (f/1.8 seems to be about average), the most significant change is in the type of lens you get; it zooms. One twist and you capture the whole family in a wide-angle picture. Another twist and you zoom in for a long telephoto shot. The typical zoom ratio (wide angle to telephoto) is 6:1. Many of these cameras give you macro capabilities: Push a button and you can focus on something just inches in front of the lens—a postage stamp will fill the TV screen on playback.

If you're on a limited budget, or not into exotic stamp shots, the standard lens will do fine. And many cameras, such as JVC's economy model, use a standard C-mount for the lens—unscrew the lens and replace it with an upgraded one later if you wish. But if you're a photo fanatic, save a little longer for the better lens—the additional capabilities it offers are worth the wait.

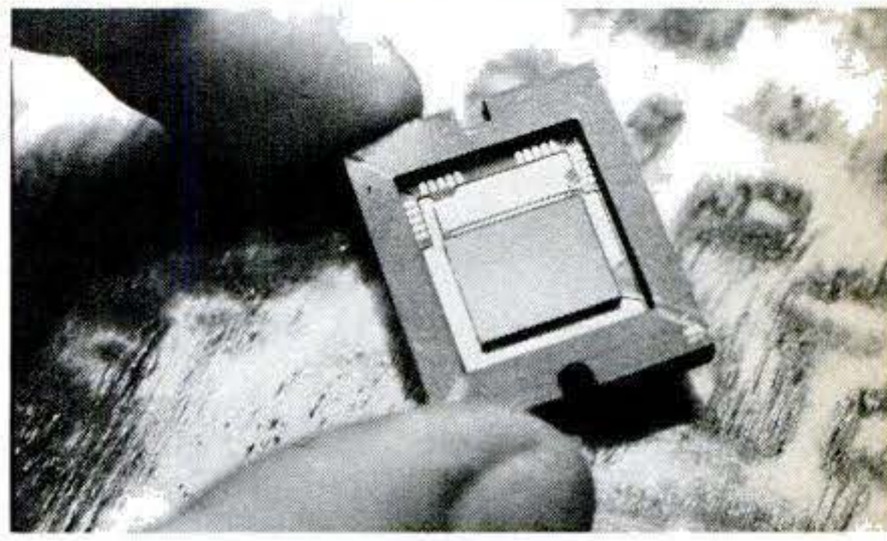
What you see is what it's got?

In photography, the human head can be decapitated without loss of blood—just a rise in blood pressure for

Continued

Sony's video camera of the future

It's five years away, Sony representatives claim, but the "video movie" is not just a dream—the working prototype shown here (facing page, and at right) is a complete video camera and recorder in one. Each miniature cassette (about the size of a microcassette, but twice as thick) holds up to 20 minutes of tape. Besides its smaller mechanics and electronics, one reason for its compact size is the use of a CCD chip (upper photo, far right) instead of a vidicon to sense a video image. Currently, the camera is placed in a home video editor (lower photo, far right) for playback on a TV screen or home recorder. Future versions may have playback electronics included. The total weight of the unit, including the rechargeable battery pack, is about 4.5 pounds.



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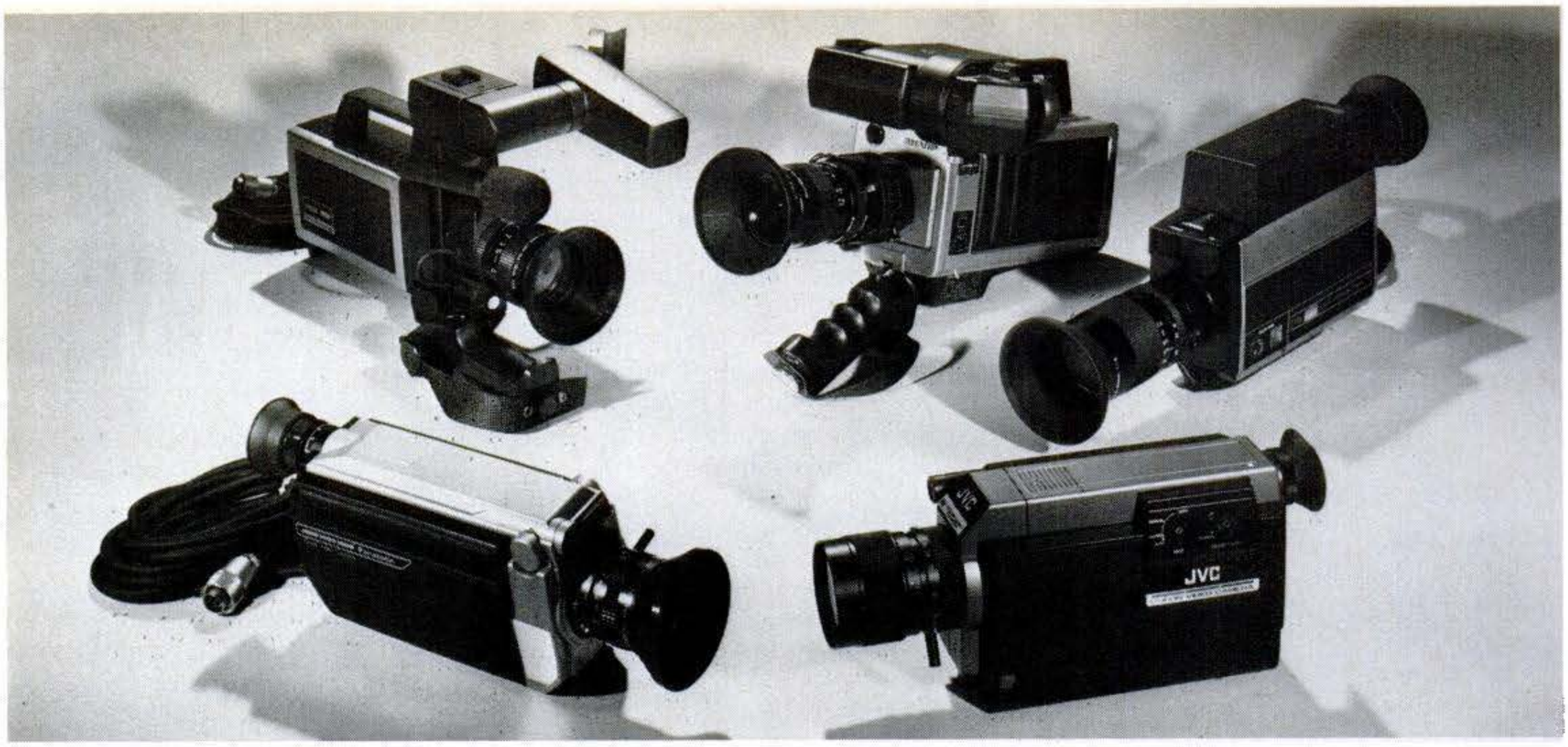

Video cameras now available include: (top row) RCA CC007; Sharp QC-35; Sears 53811; (lower row) Panasonic PK-530; JVC GX-66. Features such as Sears' color temp meter for proper tint and RCA's convenient swivel CRT help you make perfect tapes easily.

the movie viewers. Properly framing a shot is just as important in video taping. To do it, these new video cameras use one of three methods: optical sighting, through-the-lens, or electronic viewfinding.

The Zenith KC1000, for example, uses the sighting technique. You aim the camera by looking through a pop-up viewfinder and lining it up with a front-mounted sight atop the camera body. The angle between them sets the angle of the camera, properly framing the scene at an average distance. This works fine once you become accustomed to it (and you get plenty of tries since you can erase the video tape and use it again).

The through-the-lens systems (TTL) are a step up. On these—Panasonic's PK-530 is an example—the viewfinder is optically coupled to the front lens, giving you two advantages.

For one, you see precisely what the lens sees—framing becomes simple and error-free. And second, you can manually focus the image as your subjects move. With a telephoto lens, for example, this is a must.

For a film camera, a through-the-lens system is the ultimate. But for video, it's only "next best." Top-end cameras use an electronic viewfinder—a tiny 1½-inch black-and-white picture tube—to show you what's being recorded on tape. You look through a viewfinder equipped with a magnifying lens to see the CRT screen. Framing is simple, focus is precise, and even lighting is taken into account: If you can't see the scene on the CRT, it's not going on tape.

On some cameras, the CRT is mounted inside the rear of the camera body. Others, such as Sharp's QC-35, use an outboard CRT on one side of the camera. This allows you to move the camera in closer to your shoulder for easier handling and better weight distribution. RCA's CC007 uses the same idea, but the CRT will pivot—from left to right side—for minority groups. Being a "lefty," and favoring my left eye for viewing, I found this a definite plus.

The CRT can be used for other things, too. Throw a switch on the Sony HVC-2000, for instance, and you see a display of the video waveform to help you set light levels. And one big advantage of a CRT viewfinder has nothing to do with recording—you can use it to play back a tape, as well. While some scenes just can't be reenacted—like the night my three-year-old daughter fell asleep in her bowl of spaghetti—most can. Rewind the tape you just made and play it back through the camera. You see the scene—good or bad—in the viewfinder. If there's a problem, record it again. Great, but there is one catch.

Without a special connector cable (which may or may not be available), most cameras cannot play back a tape unless it's attached to a compatible VCR (usually the same brand). There are exceptions, however, such as Sears' 53811, which has a video IN connection as well as the conventional video OUT for recording. If you're buying a camera only, be sure it is totally compatible with the VCR you're using.

LED's, dials, things to try

All video cameras have circuitry that can compensate for a vast range of lighting conditions. But, in extreme changes, additional controls let you help it along.

When our eyes look at the color white, for instance, we see white, whether it's in bright sunlight or a dimly lit room. To a vidicon tube, however, color depends upon the color temperature of the source. A white color can turn reddish or bluish to the camera, depending upon whether you're shooting outdoors in sunlight or indoors under standard lighting. To compensate for it, all cameras have some sort of tint control (like the color tint control on your TV). Knowing

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where to set it is the trick, however.

For many cameras, you simply make a guess at the right setting, based on past experience. (If you're wrong, you can often correct the color with the tint control on your TV during playback.) But some cameras take guesswork out of it. Push the WHITE BALANCE control on Sanyo's VCC545P camera, for instance, and you can adjust the tint while looking through the electronic viewfinder. Inside, LED's show you when the color is correct. The Sears camera gives you a temperature display on a small side meter—aim the camera at a white surface and simply adjust a control until the meter centers.

LED's play an important role for other functions, as well. An underexposure LED, for example, tells you when to add light on a subject or when to readjust the iris to let more light into the lens (some cameras have automatic iris compensation, too). Another LED indicates whether the tape recorder is running or has paused when you press the camera tape-start trigger. Still another LED will show when the portable batteries are low (you've got about five minutes left). All these displays are in the viewfinder—you see the scene you're shooting plus a complete status check in one glimpse.

Depending upon the camera, there are a variety of other special-feature buttons, as well. They're designed to give your tapes a more professional touch. A FADE button, for example, fades into or out of a scene. And a ZOOM button controls a motorized zoom lens for jitter-free movement.

These are fine, but test every feature first, in the store, before you buy. Use a motorized zoom on a camera with a built-in mike, for example, and you may hear the whir of the motor on the sound track during playback. A quick check at the store will tell you.

Naturally, there are other things to check while in the store, too. Weight is one criterion, and the balance of the camera when you're shooting is another. If the camera feels clumsy or heavy, your taping sessions will become a real chore.

Specs? Sure, there are some you can check (see table). Signal-to-noise ratio is one. Noise on a video signal means snow to a picture. The higher the signal-to-noise ratio (expressed in dB), the less snow you should see. Another spec is the horizontal resolution—the larger the number of lines, the better the picture detail. (And it will give you an indication of the vidicon quality—there are many types.) Some specs become important depending upon how you use the camera. For outdoor portable operation, the lower the power requirement (wattage), the longer your batteries will last. For indoor use, the lower the minimum lighting spec, the less likely you'll need additional lights on your subject. Audio should also be an important consideration. If you take lots of telephoto shots (or try to tape school plays regularly), an external microphone will help. To use one, however, be sure the camera has an external mike input jack.

Buyer's guide to color video cameras

Name	Model	Price	Weight (kg)	Lens f/mm	Viewfinder	Min. lighting (lux) 1.8	Resolution	Signal-to-noise (dB)	Power consumption (watts)	Remarks
Akai	VC 30	799	1.5	1.9/15-45	TTL	100	240	45	7	Auto. iris
	VC 65	995	2.2	1.8/13.5-81	CRT	100	240	45	7.5	
Hitachi	VK-C750	750	2.2	2.8/22	TTL	100	n.a.	44	5.8	
	VK-C770	950	2.4	1.6/14-84	CRT	100	n.a.	45	8	
GTE Sylvania	VCA-101	1050	2.4	1.8/12.5-75	CRT	100	240	43	7.2	Auto. iris
J.C. Penney	636	899	3.5	1.8/12.5-75	CRT	100	240	43	7.2	
JVC	GX-33	750	1.4	1.9/15—45	TTL	100	250	45	7.5	
	GX-66	850	1.5	1.9/12.5-75	TTL	100	250	45	7.5	
	GX-68	850	1.5	1.9/12.5-75	TTL	30	250	45	5.8	
	GX-77	1050	1.7	1.4/13-65	TTL	100	270	40	4.5	
Magnavox	8245	1119	2.3	1.4/12-72	CRT	100	270	40	6.5	
Panasonic	PK-530	775	1.7	1.8/11-33	TTL	100	240	43	5.4	
	PK-700	1000	2.2	1.8/12.5-75	CRT	100	240	43	7.2	
	PK-750	1000	2.4	1.8/12.5-75	CRT	100	240	43	7.2	Movable CRT
	PK-800	1250	2.5	1.4/12-75	CRT	70	240	45	7.2	Saticom tube
Quasar	VK725	1000	2.2	1.8/12.5-75	CRT	100	240	45	7.2	
	VK730	1000	2.3	1.8/12.5-75	CRT	100	240	45	7.2	Movable CRT
RCA	CC007	995	2.5	1.8/12.5-75	CRT	70	n.a.	n.a.	7.6	Power zoom
	CC005	750	1.5	1.8/n.a.	CRT	100	n.a.	n.a.	7	
Sanyo	VCC542P	956	2.6	2.0/25	TTL	100	250	43	8	
	VCC545P	1340	3.5	1.8/17.5-105	CRT	100	250	43	11	
Sears	53811	990	2.2	1.8/13.5-81	CRT	75	250	42	8	
	53801	830	2.2	2.8/25	OPT	75	250	42	8	
Sharp	QC-35	1095	3.5	1.8/17.5-105	CRT	100	240	45	7.2	
Sony	HVC2010	800	2.0	1.8/13-26	OPT	70	300	45	6.5	Trinicon tube
	HVC2000	1250	2.4	1.8/12.5-75	CRT	70	300	45	8.3	
Toshiba	IK 1650	1345	2.2	1.8/18-105	CRT	100	250	46	11.4	Zoom option
	IK 1850	1045	2.6	1.4/11-70	CRT	50	260	46	9.9	Auto. iris
Zenith	KC1000	995	2.2	2.0/25	OPT	100	250	40	8.5	
	KC1250	1395	2.8	2.0/17-102	CRT	100	250	40	10.8	

In use

What fascinates me most after using these cameras is how much they've changed me—the instant playback and erase-and-try-again features of video tape make it all fun. I found myself shooting flowers, animals, people I didn't know—all the things I would never consider with three-minute super 8.

To be fair, however, super 8 is still more portable than video. Besides the camera, you'll need a portable VCR, fresh batteries, extra tapes, and maybe lights with an extension cord or two. Portable VCR systems do have fantastic advantages for home "movie" takers, but, for now, taking one along on a vacation is like taking your microwave oven along on a cookout.

Despite the portability problem, the results I've gotten from using a video camera have been excellent. And watching home "movies" is no longer a chore. There's no screen or projector to set up—just pop in the tape and turn on the TV. Picture quality is excellent.

If you're concerned about all the old super 8 movies you already have, there's an answer for those, too. You can buy special camera attachments (about $90) that allow you to project the movie into the camera—record it, and you've converted super 8 into video tape. And, if you don't wish to do it yourself, Fotomat will do it for you. Drop off the film at any of its outlets. You get a video-tape copy in about a week.

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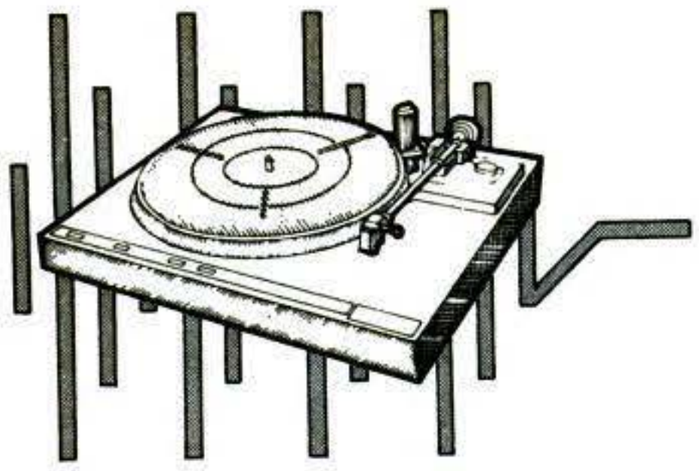

New accessories

for hi-fi sparkle

PHOTO BY JOHN KEATING

Cassette accessories in the form of tapeless cassettes include Robins' $27 WhistleStop electronic head demagnetizer (1) and similar TDK HD-01 $22 demagnetizer (2). Jeweltone's head-cleaning tape from Osawa (3) is $8. DB Systems' $25 DBP-6 phono-equalization kit (4) lets you match cartridges with capacitors plugged into Y connectors on preamp. The $60 limited-edition record weight (5) from Keith Monks and the $14 KMAL/RW/60 (6) fit on turntable spindles to help dampen disc vibrations; they may also reduce disc-warp problems. Larger, $43 GL601-II crystal weight from Osawa (7) has built-in leveler. Bib's $10 turntable mat (8) contains carbon fibers to dissipate static from discs. Kenwood's $160 TS-10 turntable sheet (9) is a ceramic-and-rubber disc said to cut vibrations. Watts' $15 record and stylus-care kit (10) has antistatic fluid and Parostatik Disc Preener. Disc kit from Empire (11) includes its $40 Static Eliminator with piezoelectric element; squeezing trigger releases positive and negative ions. Audio Groome's Disco-Film (12) from Empire deposits peel-off coating for cleaning 40 LP sides; it's $30. The $20 disc kit from Osawa (13) has a spray-type cleaner. Goldring's $30 Ex-Static sweep arm (14) drains static and picks up dirt. The $20 Pod (15) from Eon cuts disc vibrations and flattens some warps by clamping discs to spindle; similar $15 Bib Record Clamp (16) has speed strobe markings. Cassette rerecord kit from Bib (17) costs $6 and has 72 tabs to block holes in prerecorded cassettes. Bib's $9 XL-2 Groov-Guard (18) with velvet cleaner and 20-record spray-on fluid has been upgraded for audiophile product line; Bib says fluid cuts static for life of discs. A $5 cassette winder (19) winds tape (by hand) faster than most recorders, says Bib. Bib's $35 Electronic 3000 Groovstat (20), an ion generator, helps cut disc static. The $50 N103 Kilavolt (21) from Osawa also makes antistatic ions. Jeweltone CW402 from Osawa (22) rewinds cassettes by motor; $20. Robins' $5 T-type turntable leveler (23) has dual bubbles. Bib's $15 kit (24) simplifies cleaning of tape-recorder heads.—*John Free*

MANUFACTURERS' & DISTRIBUTORS' ADDRESSES

Bib, 1751 Jay Lell Dr., Richardson TX 75081; **DB Systems,** Box 347, Jaffrey NH 03452; **Empire Scientific Corp.,** 1055 Stewart Ave., Garden City NY 11530; **Eon Research and Development Corp.** (distributor is Hervic Electronics Inc., 18750 Oxnard St., #406, Tarzana CA 91356); **Goldring** (distributed by Hervic, above); **Keith Monks Audio** (USA), 652 Glenbrook Rd., Glenbrook CT 06906; **Kenwood Electronics, Inc.,** 1315 E. Watsoncenter Rd., Carson CA 90745; **Osawa & Co. (USA) Inc.,** 521 Fifth Ave., New York NY 10017; **Robins,** 75 Austin Blvd., Commack NY 11725; **TDK Electronics Corp.,** 755 Eastgate Blvd., Garden City NY 11530; **Watts** (distributed by Empire Scientific, above).

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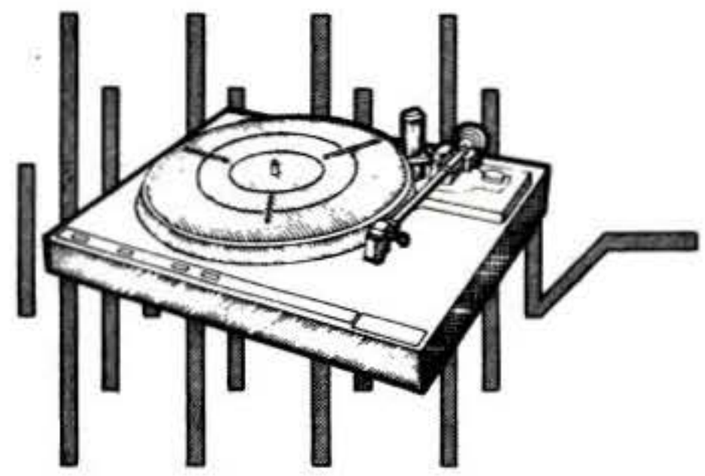
By LEN FELDMAN
DRAWING BY ROY DOTY



Computerized equalizer

fine-tunes your sound

An equalizer—computerized or not—is really a refined form of tone control. It lets you set the tonal sound of your speaker system. But unlike tone controls, an equalizer lets you boost or cut up to 10 specific audio frequency bands—it doesn't make broad bass or treble sweeps. The result: Your system, despite speaker placement and room acoustics, reproduces all frequencies at the same volume—a flat response.

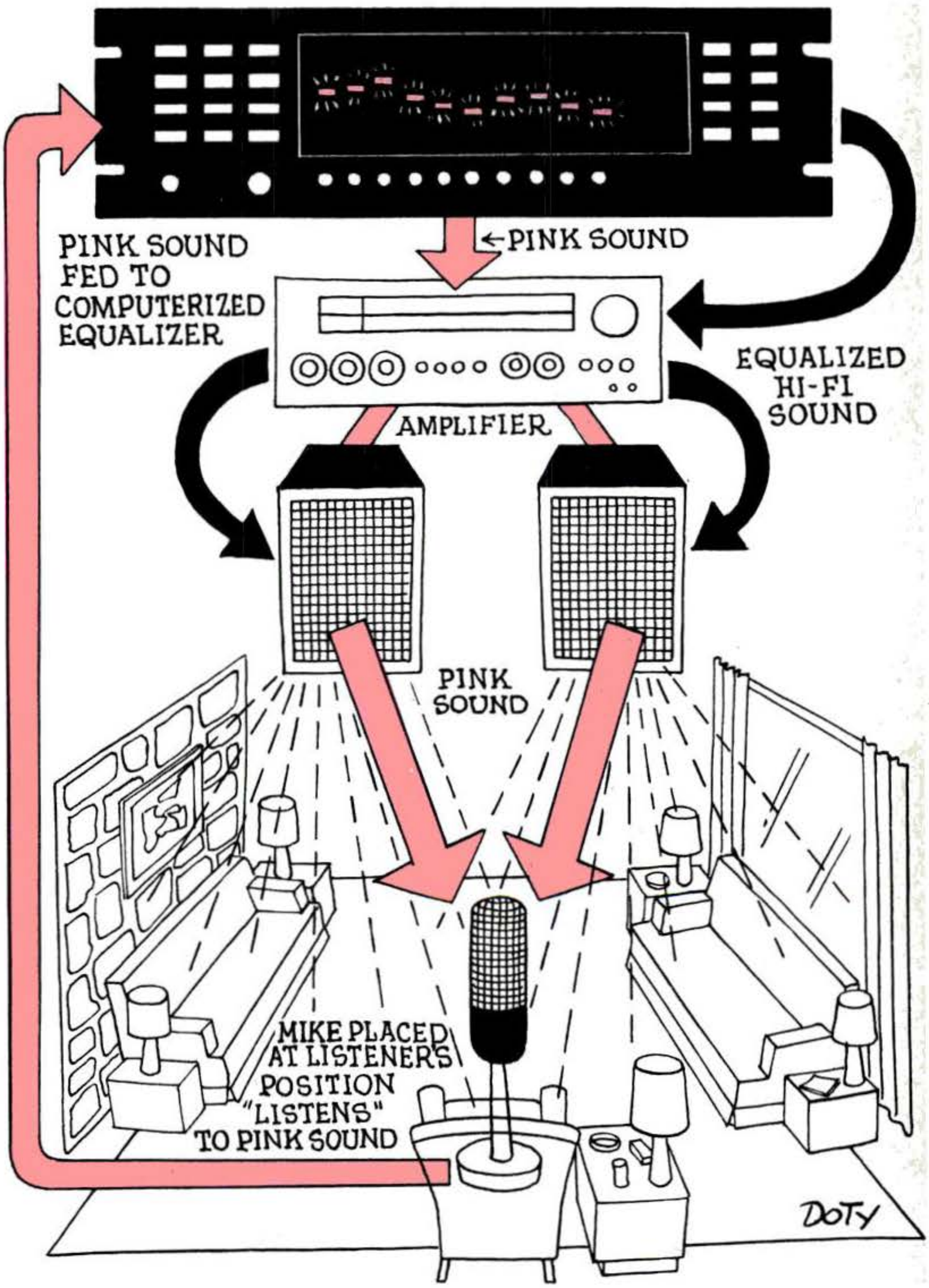
So what can a "computerized" equalizer boost? Price, for one thing. At $1300, the model 20/20 from DBX, 71 Chapel St., Newton, Mass., is certainly expensive. It is also probably the most sophisticated hi-fi add-on gear you can buy.

The 20/20 does everything a standard equalizer does—but does it automatically. In fact, Bob Adams of DBX proposed the computer idea after spending hours trying to set up a standard equalizer in his home. It seemed that every time he adjusted one control for a flat response, it interacted with other controls he had set.

"Wouldn't it be nice," he mentioned to Les Tyler, DBX's chief engineer, "if a computer could adjust the controls." Two years later, the 20/20 was finished.

The result is really many instruments in one (see drawing). First, it has a source of "pink noise" (noise containing equal amounts of energy at all audible frequencies), which is sent through your amplifier-speaker system. To "listen" to the sound from your speakers, there is an attached microphone. This feeds the room sound to an analyzer that measures the instantaneous sound levels at specific frequencies. The computer section of the unit then uses this information to automatically set its 10-band equalizer, precisely adjusting the volume for every octave in the audio spectrum. To show you what's going on, a bank of 300 LED's displays the response of your system.

Watching the unit go through its paces is a treat: You simply place the microphone at your favorite listening location and push a button. The LED's instantly start moving about as the computer hunts for the optimum setting for each octave level. The whole operation takes about 10 seconds. The 20/20 will memorize the settings for up to 10 different listening positions. The final settings of the 10 controls can be "frozen" on the display, or, with another button, you can see a plot of the newly achieved flat curve. And a meter displays the overall sound pressure level in decibels. HS



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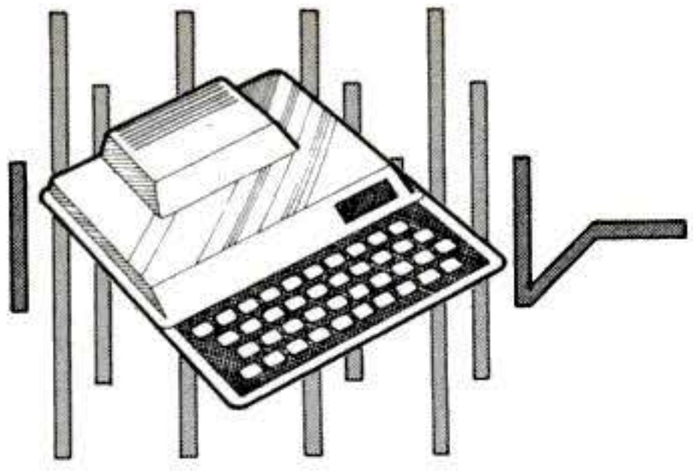

Hand-held computers

At home, in the office, on the road—these small computers give you brainpower to go

By V. ELAINE SMAY

One evening last week as I closed my file folder labeled "Hand-Held Computers," I thought it felt a bit lumpy. Sure enough, tucked inside, unseen among the papers, was one of the little buggers, the Sinclair ZX80.

The ZX80 is one of a whole new generation of personal computers that, if not quite pocketable, are at least small enough to be carried in an attaché case. Panasonic, Quasar, Commodore, Newbury Laboratories, and Sharp are to begin selling very small computers in the U.S. sometime this winter. Radio Shack and Sinclair already are.

These machines are true computers. They can be programmed in BASIC, the pidgin English people use to communicate with many computers. And you will be able to buy prepared programs (software) for them to do such jobs as keeping track of your personal finances or teaching your kids arithmetic. All will be relatively inexpensive—from $200 to $500.

And all will be portable, but not to the same degree. The Sinclair, the Commodore, and one of the three models from Newbury Labs depend on AC power and have no built-in display; they must be hooked up to a television set or video monitor. So while they're small and light enough to tote from home to office, they can only be used where line power and a television screen are available. The others, however, have a one-line integral display and can run on battery power.

These hand-held computers differ considerably in just what they can do and in what accessories (peripherals) can be used with them to make them do more. For example, if you want to transfer the information on the display to paper, you need a computer that can drive a printer. If you want access to consumer data banks, such as The Source or MicroNET (see "Info Banks Make Your Home Computer Smarter," this issue), you'll need a modem (modulator/demodulator) so that your computer can talk over telephone lines to another computer. If you want to write programs and store them, you need a computer that can use a tape recorder to transfer data to and from cassette tapes, or one that hooks up to a disk storage system, a high-speed recording device that saves data on floppy disks of magnetic recording material. Some of these peripherals will be available for some of the computers, but not all for all.

Finally, these little computers come with relatively small memory space, which limits the complexity of the programs and data they can handle. If you want to be able to graduate to more sophisticated programs, look for one to which memory can be added.

Following is a closeup look at six of these new computers. The seventh, the Sharp PC-1211, is available in Japan. Our contributor, Michael White, got one there and tells how he uses it in the article that follows.

Radio Shack

The TRS-80 Pocket Computer measures seven by 2¾ by ½ inch, weighs six ounces, and is powered by four mercury cells. Its liquid-crystal display has space for 24 characters. (See "What's New in Electronics," this issue, for a photo of the TRS-80.)

"We've found that a lot of the things you can do with the Model I TRS-80 desk-top computer can also be done with our new pocket model," says David Burdick, director of computer center merchandising at Radio Shack. "Although it has only 1.9K (kilobytes) of random access memory (RAM) compared with 4K for the Model I, it can handle longer programs than you'd think because of the specific BASIC it uses." Its 1.9K memory cannot be expanded.

The Pocket Computer is a versatile calculator, with 15 arithmetic functions, a floating decimal, and accuracy to 10 digits. "It will perform anything the programmable calculators do—as well or better," says Burdick. "And it is a lot friendlier because it prompts you in English."

The TRS-80 Pocket Computer sells for $250; an optional cassette interface is $50. With that, you can save your own programs and use the software (on cassettes) that Radio Shack sells. Eight programs are now available. Another half dozen are in the works, Burdick reports. The company is considering making a printer for the TRS-80, and maybe a modem.

Quasar and Panasonic

The Quasar Hand-Held Computer and the Panasonic RL-H1000 are nearly identical machines, developed by Matsushita, the parent company. They are nine by 3¾ by $1\frac{3}{16}$, have one-line, 23-character liquid-crystal displays, and run on either rechargeable nicad batteries or line current. Both should be on the market by December. Target price: $400–$500.

For that you get a machine that is not really a computer—you can't write or run programs on it. But it can do a number of useful things. It has a clock/calendar function that keeps

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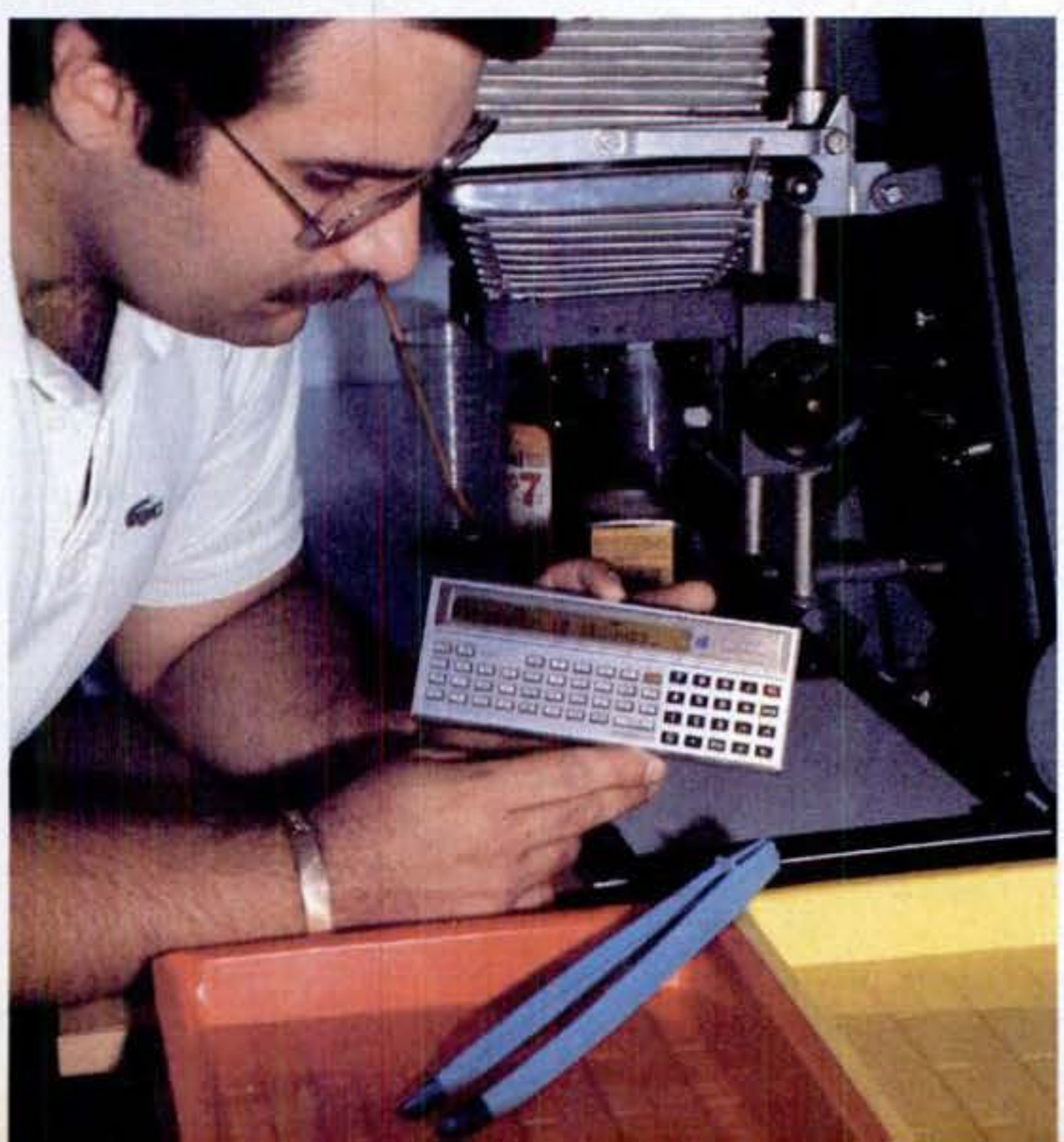

Sinclair ZX80 comes with video cable that connects to UHF terminals on TV; display is black on white. Programs can be saved on tape cassettes and loaded from tape. Cables from MIC and EARPIECE sockets on the cassette recorder connect to ports on the ZX80. Getting the recorder to work with the computer can be tricky, however. The owner's manual offers some hints.

Sharp PC-1211 has one-line display and runs on batteries. Author White (following story) uses it frequently in his darkroom. He has programmed it to time fixing and washing operations simultaneously, and he uses it to scale formulas for precisely mixing developing chemicals. The PC-1211 is not yet available in the U.S., but the Radio Shack TRS-80 Pocket Computer is similar.

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track of the year, month, date, hour, minute, and second. In this mode, it can be an electronic appointment calendar. "You can set alarms," says Phil Callihan, Quasar's product manager, information processing systems, "and you can put in a message. When the alarm goes off you push a button, and the display reads, GO TO LUNCH WITH GEORGE."

The hand-held computer also can act as a memory file to store addresses, phone numbers, formulas, and notes. And it is a four-function calculator.

To do more with it, you have to buy more stuff. For example, it knows how to work as a language translator. But to use that function you must buy a preprogrammed read-only memory (ROM) chip that plugs into the back. Four of these add-on ROM's can be used at a time; an optional interface device lets you add four more.

A plug-in ROM will also teach the computer BASIC so you can program it. But you won't be able to do a lot of programming because the computer contains only 1K of RAM. Initially, the companies will sell a 12K-RAM expander module. The machines are capable of expanding up to 73K, and possibly more.

Highest on the priority list of peripherals are a miniprinter, modem, cassette-recorder interface, the 12K-RAM expander, and an input/output (I/O) interface that lets you use more than one peripheral at a time. "Further down the line we're planning to offer a TV interface, more RAM, and disk storage," says Dennis Reer, Panasonic's senior project engineer for digital products.

Sinclair

The Sinclair ZX80, introduced to PS readers in May (see "Hand-Held $200 Home Computer"), is 6½ by 8½ by 1½ inches and weighs 12 ounces. It has no display (you must connect it to a TV set), and it's powered through an adapter from an AC outlet. It generates a black-on-white display with 24 32-character lines. The keyboard is a flat, touch-sensitive type. It includes 24 standard graphic symbols as well as the usual alphanumeric keys.

The ZX80 has 1K of RAM built in. For more sophisticated programming you can expand the memory to 16K with an optional RAM expansion module (cost: $100). The BASIC the Sinclair comes with does only integer math. "But you can take out that ROM chip and plug in another that will have a more powerful version of BASIC with a floating decimal and all the advanced mathematical functions," says Nigel Searl, Sinclair's marketing director. Cost: about $40.

The ZX80 has a built-in cassette-recorder interface. By January, Sinclair expects to have a low-cost printer available. Other peripherals are likely later.

Newbury Laboratories

The NewBrain, made by Newbury Labs in England, rated a spot in last month's "What's New in Electronics." Plans are to have it available here by January or February.

At 10¾ by six inches and weighing three pounds, the NewBrain is larger than the others. Reason: It has a full-size typewriter-style keyboard that allows fast touch-typing.

The NewBrain comes in three models. Model M uses line current and has no display. Model MB uses line current, but also has rechargeable batteries; thus you can use it for short periods in the field. It has a one-line, green fluorescent display of 16 characters; it can also be used with a TV. Model MBS is similar to the MB, but has lower current consumption, so it can run for extended periods on battery power. British-equivalent prices are $376, $474, and $593; American prices haven't been set. All three models come with 2K of RAM. Additional memory modules can be added.

The NewBrain's BASIC includes floating-point decimal mathematics accurate to 10 significant figures, and all trigonometric and inverse trig functions.

Two cassette tape recorders can be used with the NewBrain, and the company makes a compatible printer. The computer has ports for various other devices, as well.

Commodore

Commodore expects to introduce a portable computer in January. Exact size has not been determined. "But it will fit easily into a briefcase," says Michael Tomczyk, marketing director. The Commodore will have a full-size keyboard. It will use line current and have no display.

The computer, code-named the VIC, will generate a color image on the TV screen. It will come with 4K of RAM available to the user, and will accommodate expansion memory modules. "To what extent hasn't been decided," says Tomczyk, "but I would say at least to 32K." The VIC will use the same BASIC used in Commodore's PET desk-top computers.

Commodore is planning to manufacture an inexpensive printer for the VIC, and either a cassette-recorder interface or a disk driver. In addition, the VIC will have a standard adapter, called an RS-232 interface, built in so that many existing peripherals, including the PET modem, will work with it.

Programs, on plug-in ROM capsules, are being developed. One, a game program, should be ready by January. Another will provide graphics, the company says. PS

Quasar portable computer uses an acoustic coupler/modem to telephone other computers. Panasonic's is nearly identical, but keyboard is arranged like a typewriter's; Quasar's is alphabetical. Panasonic will sell computer and selected peripherals in attache cases (Quasar may also). Both will sell separate modules.

MANUFACTURERS' ADDRESSES

Commodore Business Machines, Inc., 950 Rittenhouse Rd., Norristown PA 19403; **Newbury Laboratories Ltd.**, 68 Regent St., Cambridge CB2 1DP, England; **Panasonic**, One Panasonic Way, Secaucus NJ 07094; **Quasar Co.**, 9401 W. Grand Ave., Franklin Park IL 60131; **Radio Shack**, Tandy Corp., 1800 One Tandy Center, Ft. Worth TX 76102; **Sharp Electronics**, 10 Keystone Pl., Paramus NJ 07652; **Sinclair Research Ltd.** (U.S. office), 50 Staniford St., Boston MA 02114.

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How I use my pocket computer

By MICHAEL WHITE

Personal computers are very useful, but they're seldom around when I need them. Programmable calculators, on the other hand, are easily portable, but most are quite limited in their capabilities. And all must be programmed in an argot of keystroke sequences—a cross between computer machine language and Sanskrit. What I wanted was a machine that combined ease of programming, sufficient computational power, and true portability.

I got it in the Sharp PC-1211 Pocket Computer. It's small, battery-powered, and programmable in BASIC. The PC-1211 is only available in Japan, but through a friend I got one.

The PC-1211 measures 6⅞ by 2¾ by $^{19}/_{32}$ inches and weighs just under a third of a pound. It is powered by three button-cell batteries. The 24-character liquid-crystal display will scroll up to 80 characters. The alpha keyboard (caps only) is laid out like a typewriter. Numbers are entered via a conventional 10-digit keyboard. The only function keys are +, −, ×, ÷, and $\sqrt{\ }$. All other functions are spelled out on the keyboard. Trig functions and their inverses, logs, and absolute values are included.

The memory consists of 1424 bytes of user-addressable random access memory (RAM), which I find amounts to 200–300 average BASIC program lines. (The Sharp PC-1210 is identical to the PC-1211, except that it has only 400 bytes of RAM.) Most BASIC software can be readily adapted for the PC-1211. It is also easy to write custom programs with it. Programs can be stored on a cassette tape by means of the CE-121 adapter. I found that the choice of tape recorder is critical. Fairly high quality—for recorder and tape—is required.

I work for a consulting firm designing communications systems, and programmed the PC-1211 to do a number of analytical algorithms I frequently use. Now I can work at my desk rather than having to march down the hall to the computer terminal. I can also do computations at home, while traveling, or even while waiting at a traffic light.

Pocket navigator

My first extracurricular use of the PC-1211 was in my airplane. A little judicious programming yielded a flight computer customized to my plane and the routes I fly. The computer displays the name of the radio beacon or airway intersection I am flying to, the time to go until I reach it, and the distance remaining. When I pass the beacon I push a key and the computer notes time en route. A comparison with estimated time allows the computer to update its wind data, yielding a new estimated-time-of-arrival at the next checkpoint.

My first trip with the computer took me to an unfamiliar area. When I arrived over what I thought was my destination airport, the computer showed five minutes to go. Muttering about bugs in the timing routine, I landed, only to find that I was at the wrong airport.

Computer in the darkroom

Photography is the other hole down which my spare cash goes. Once again, the PC-1211 puts computing power right where I want it. In the field, a simple TABLE LOOK-UP program lets me put in filter or extension-tube types by name, and reads out exposure correction factors. A record-keeping routine allows me to key in each frame's exposure.

In the darkroom, I compute enlargement ratios and contrast-filter correction factors with the PC-1211. The computer's display is easily seen under an amber safelight.

How does the PC-1211 stack up against a programmable calculator or a desk-top home computer? The Hewlett-Packard HP-41C calculator, for example, offers alphanumeric capabilities, and is in many ways a more powerful calculator. It is certainly faster, and, with a full complement of memory modules, will store a larger program. The HP-41C has an optional printer, which the Sharp unit does not, but program storage is on small magnetic cards, and many must be passed through the reader for a large program. The cassette storage used by the PC-1211 is certainly easier. More important, the HP-41C lacks the high-level programming available with the PC-1211.

The Sharp, including cassette interface and customs duty, cost me just under $200. The HP-41C sells for around $260; card reader, printer, and memory modules are extra.

A conventional desk-top home computer would boast greater memory capacity—at least 4 kilobytes compared with 1424 bytes for the PC-1211. Most are faster and offer graphics capability, which the Sharp lacks. Full-size home computers usually have more accessories, including disk storage units.

The instruction set of the PC-1211 is more powerful than that of some home units; for instance, the Radio Shack TRS-80 desk-top computer's level 1 language does not offer trig functions.

But, most important, the PC-1211 is portable. My next venture with it is going to be celestial navigation—aboard a 40-foot sailboat on a cruise to Bermuda. PS

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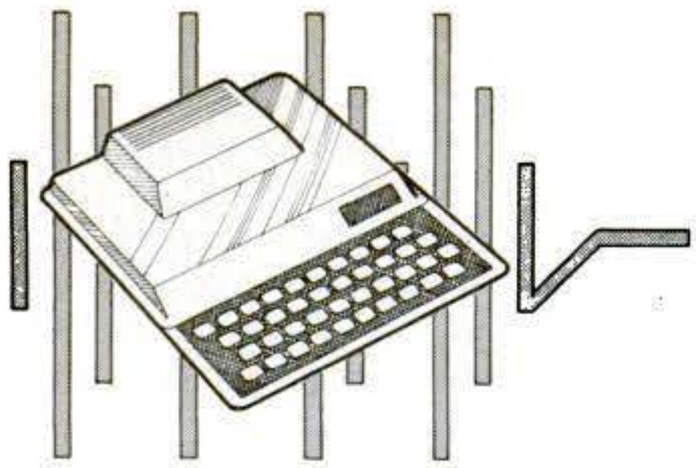


Info banks

make your home computer smarter

Now they give us instant answers. In the future, these data services could change our lives

By WILLIAM J. HAWKINS

The computer terminal in front of me was black except for the small square cursor that showed where a word would come out on the screen.

I dialed a special phone number. The phone rang at the other end and a steady whining tone answered my call. Suddenly, the cursor began to move, leaving letters in its wake. I was now connected—"logged in," in computer jargon—to a remote computer system ready to supply me with information from more than 2000 data banks and computer programs.

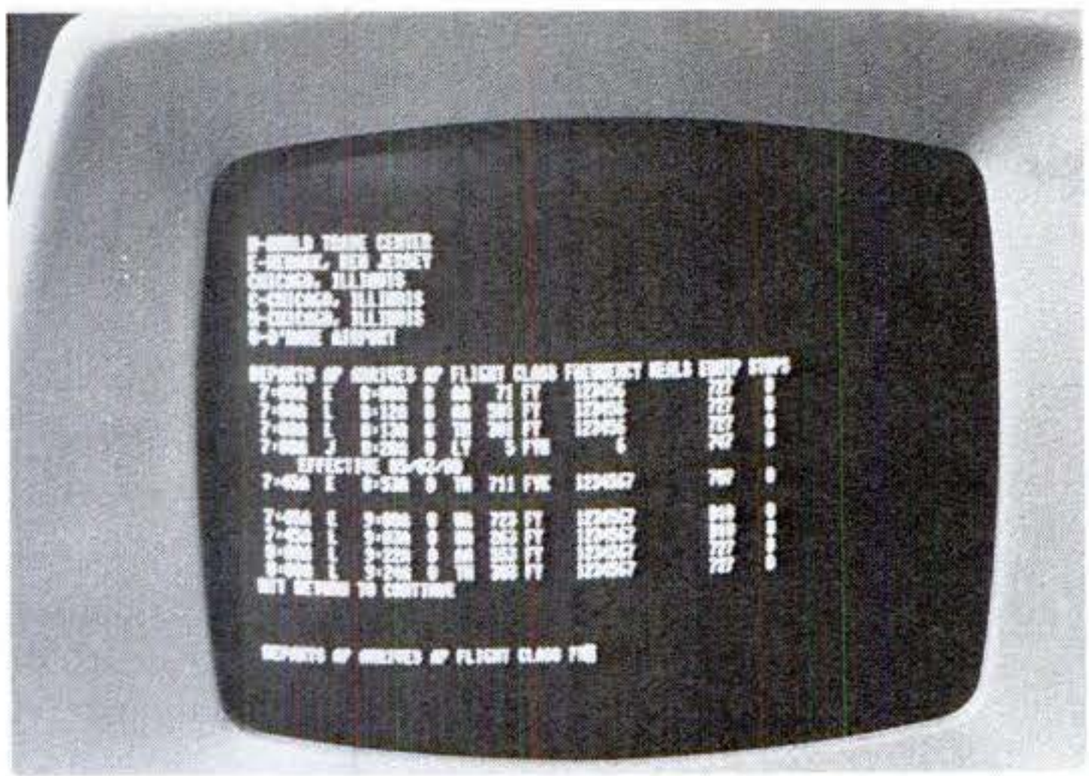
No, I'm not in front of a giant IBM; I'm at home. And, at the push of a keyboard button, I can get anything from news to airline schedules to ball scores. I can even find out what wine goes best with tonight's dinner.

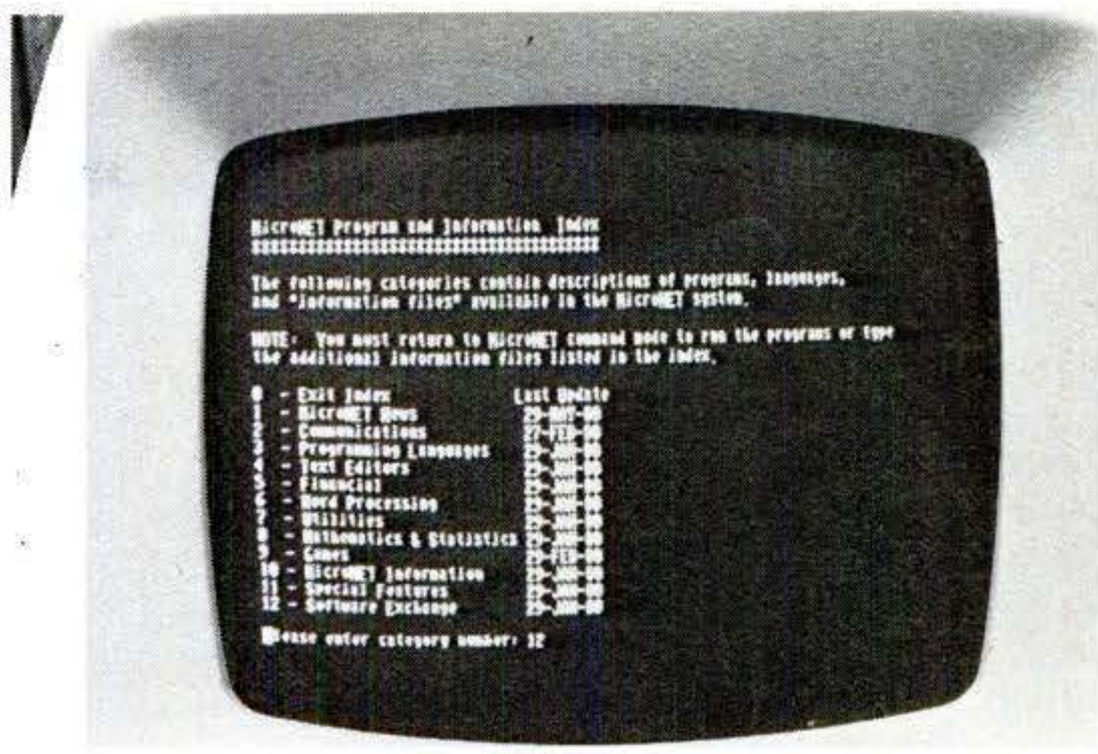
Computer information services are not new—businesses have been using them for years. But now there are at least two new services—called the Source and MicroNET—that are specifically aimed at individuals. They require little equipment, and the cost to sign up and use the systems is reasonable: from $2.75 an hour on the Source and from $5 an hour on MicroNET. Prices depend on time of day and other variables. There is also a one-time, initial hookup fee of $100 for the Source and $9 for MicroNET.

These new services are a quick and easy way for anyone to get info on virtually anything. But they go much

Author's home computer is an IMSAI equipped with an IDS 88-modem board for direct connection to the phone line. Data, to or from the ADM terminal, is processed through the computer. In that way, Hawkins can "grab" any screen of data and save it on a disk for future use.

On the display





For instant information, you just push a keyboard button. A selected airline schedule, left, appears from the Source. MicroNET's system, right, starts you off with a "menu" of categories. Each display of data is numbered (by paragraph or page, depending on the system) for quicker operation once you become used to it. In reality, you're connected through a host computer system, such as Tymshare, which routes the data and allows many people to "share" a data computer.

deeper than just information retrieval. Their potential is enormous. They may change the way we live. Here's how they work.

"Big" computer power

Each time you type a request on the keyboard, the characters are sent over phone lines to a remote computer—possibly thousands of miles away. (Don't worry, you're billed only for a local phone call from most major cities in the country.) The computer finds what you're looking for, either in its own memory banks or from other computers it has access to, and sends the answer back, one character at a time, to your terminal. Your question is answered in seconds. And you don't need special gear.

"That's a standard Atari home computer," MicroNET's Mike Ward told me at a demonstration in Chicago. "All I've done is plug our 'conversion' software package into it. What you're seeing on the screen comes from MicroNET in Ohio."

Software—the programs that tell a computer what to do—has been developed by both MicroNET and the Source for Atari, Apple, and Radio Shack computers. Turn on your computer, load in the special software, and you're ready to go. It means that virtually anyone with a home computer can get big computing power simply and easily. Experts predict that by 1985 one out of every four homes in the U.S. will have a home computer—probably close to the prediction made when the telephone was invented.

A computer in nearly every home? If that's to be, and if the information services are to grow, they must be simple to use—"friendly," in computer jargon.

Push the wrong button on your computer, for example, and it politely tells you, adding instructions for future reference. Give it the wrong command, and you're quickly given the right one—or a guide to the right ones if the computer is not sure what you want. Use the wrong language—cuss at it—and you're warned to "clean it up" or your service will be cut off.

"We've recently changed our system," MicroNET's Ward told me, "to make it more friendly to everyone. It is now 'menu' oriented."

In a menu system, the computer starts off with a simple list of general items: news, weather, games, special services, for example. Once you choose one, the computer branches to that category, giving you a more detailed menu of that particular subject. If you choose NEWS, it may come back with: WORLD NEWS, NATIONAL NEWS, LOCAL NEWS, OR BUSINESS NEWS? After you choose one of those, it then gets even more specific.

The Source will work that way, too, but you must first give it a command to display the main categories. If you don't want to go through the menu orientation (you know from experience precisely what you want and how to get it), you can type in a specific command to get a certain bank of info.

Data-bank index

When you subscribe to the Source, you also get a book of subjects listed in alphabetical order. Look up the subject—from gardening to card tricks—and type in the respective command. The problem, however, is keeping the book up to date, since the Source routinely adds programs to the system. Source's solution is a monthly magazine, *Sourceworld,* to keep subscribers informed of additions or changes.

Editor of *Sourceworld* and director of corporate communications for the Source is Noel Tyl. I visited him at the Source headquarters in McLean, Virginia.

"Welcome," he said as I entered his office. "Be right with you. Just answering some mail."

As he spoke, his fingers jumped over the terminal keyboard on his desk. "Sometimes I get as many as 30 letters a day," he said. "I try to answer them all, but some I must pass on to our customer service people."

"There!" he said, hitting the last button to send his electronic reply back to a subscriber. "That's it for now, but the system tells me I've got four more letters waiting for me. Time for that later."

Electronic mail [PS, Sept.] is just one of the additional features of a computer-operated communications system. It allows anyone to send letters to anyone else—either directly through the system or through a mail service that automatically delivers a telegram within 24 hours. It will go the other way, too.

"Suppose you're at the airport," said Tyl, "and you want to give a message to your wife, who's not home at the time. Just get to a phone, call the Source using a toll-free number, and dictate the message to one of our people. When your wife gets home and 'signs on' to the Source, the system tells her there's a message—and a typewritten copy of what you told us at the airport appears on her screen."

Except for the terminal, Tyl's office was surprisingly void of computer wizardry. Papers to be shuffled were on his desk, "people" pictures covered the walls, and ordinary clocks told the time—not a printout in sight.

Continued

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"I don't know an RS-232 from a magnetic-tape drive," said Tyl, "and I don't want to. We're not offering a computer—that's just two boxes that look like refrigerators. We are offering an incredibly easy-to-use service. It's for everybody."

Before Tyl could finish, his phone rang. On the other end was a man from Indiana who had heard about the Source and wanted to know more.

"Give me a test," said Tyl. "What would you like to know?"

There was a moment of silence before Tyl began striking the keyboard again. "Let me get this straight," he replied, now trying to balance the phone between his shoulder and cheek. "You want to know what planes fly between Tel Aviv and Cairo between noon and 3 p.m., right?"

Within seven seconds (yes, I timed it), Tyl began reading off the data from the screen to his caller. It included everything from flight numbers to the food that was being served.

Obviously, not everyone will get an answer in seven seconds. How well you do depends on how familiar you are with the system—as I found out.

Logging in

Although these systems may be friendly, they don't smile much unless they know who you are. You're given passwords and numbers that must be used in exactly the correct order or the computer assumes you're trying to get free information.

ILLEGAL PASSWORD, were the words across the screen on my first try. It is truly not comforting to have a computer tell you that you're a thief; stealing computer time is illegal—a jailable offense. Would this thing call the FBI's computer? Would I hear sirens at my front door in moments?

PLEASE CALL YOUR SERVICE REPRESENTATIVE. Click.

"Thank goodness," I thought. All it did was hang up on me. My problem: One of the numbers I was given was wrong. That's understandable, since the sequence makes remembering your car registration number seem simple.

Once logged into the system, however, it can overwhelm you with helpfulness.

BALL SCORES, I typed after giving the command to get into the UPI news service, figuring I'd see how the Yankees were doing.

UPI NEWS SUMMARY, came the reply. BALL SCORES—MEXICO CITY.

Wait a minute. Mexico? No. STOP. QUIT, I typed. All in vain. Twenty minutes later (it seemed) the display of statistics covering ball games in Mexico finally stopped. I had learned a little about being more specific in my requests—and a lot about baseball in Mexico.

EINSTEIN, I typed, figuring you can't get more specific than somebody's name. Wrong again. What I got was a review of a new book, *Home Before Night—Memories of an Irish Time and Place,* in which he was referenced.

EINSTEIN, I tried again.

My next 10 minutes were spent reading a biography of Sigmund Freud, which, to my misfortune, compared him to Einstein. If this was the beginning of the electronic information age, I was ready for a good book.

EINSTEIN, DAMN IT! I typed, as I now found myself talking out loud.

SLAVE ABORT, came the response. BAD PASSWORD. Oh, well, I didn't want to know about him anyway.

Although your first few hours with these systems could be a bit frustrating, it's not long before you catch on and begin getting what you want. It wasn't long before my wife began using the system to get real-estate information and my five-year-old daughter started playing some of the games.

I also got to "talk" to other users on the Source's "Chat" program and MicroNET's clever "CB simulation" program. (It turns your terminal into a 40-channel CB set that lets you tune individual channels for other people on the system.) These programs let you communicate with anyone else—anywhere in the country. You type what you'd like to say on the keyboard, and the response comes out on your terminal. It's fun, but not fast. In a 20-minute conversation I had with someone in Boston, we exchanged only about 10 short paragraphs each. A phone call would have been quicker.

Some of the data banks I got into (either on purpose or by accident) brought up some interesting questions for the future of home information systems.

For example, if you want to take a trip, there's a travel agency on line that will help you with all kinds of information. But before getting it, you must sit through a short message giving the agency credit for the data. Understandable, but that's a commercial! Will Budweiser sponsor future ball scores? Could Gallo bring you the latest wine list? Will Phillips Milk of Magnesia present local restaurant guides?

Another feature of these systems is a "bulletin board"—you can buy or sell things, make dates (the Source's president's son made his first date over the system), or just post anything you'd like other users to know. The first time I "looked" at the bulletin board, I got: PUT JOHN ANDERSON ON YOUR BALLOT. It was a political boost put there by the "Anderson for President" headquarters. Could Carter demand equal time? Should Anderson pay for his?

Could all of that mean future government control by, perhaps, the FCC or FTC? Naturally, with anything so new, there will be lots of questions—and problems—to work out. What makes this unique, however, is its overwhelming potential. Like TV, it could actually change the way an entire nation thinks.

What's ahead?

There are literally thousands of programs and data bases available on these systems, ranging from games to language-learning to stock questions—too many, in fact, to even try to list here. Right now, between the Source and MicroNET, you can get news headlines from a dozen national papers and the UPI and AP wire services. MicroNET alone has more than 30 other newspapers just waiting to add info to the system. The Source is presently negotiating for magazine material as well, and is working closely with the government on a bill to cut paper waste in the U.S.

Future newspapers and (gulp) magazines may not come to your front door—they may very well be on your home computer screen instead. And they will be written by writers at home, who will then send their electronic copy to editors on the system.

Clothes, food, and gift shopping may all be done from your video screen (a gift-shopping guide is already available on the Source). Door-to-door salesmen may never leave their homes—and you'll be able to reject their pitches by just turning off the screen. The U.S. mail may never get another letter to lose. Bank tellers may never see another human being. Cash—and credit cards—may become obsolete. And "rush hour" may become a dream of a bored traffic cop.

Am I dreaming? Perhaps. But perhaps not. Keith Fuller, president of the AP, said there are two main views of these systems: "One, that electronic delivery is the future knocking at the door; and the other, that electronic delivery to the home is a disaster hunting a victim." But he added: "We're going to find out which."

The Source's Tyl has already made up his mind about the future of home info services: "Not long ago, when you got a hotel room, you looked for a TV set. Soon, you looked for a color TV. Someday—and it won't be very long from now—you'll look for a computer terminal." PS

FOR MORE INFORMATION

Telecomputing Corp. of America (the Source), 1616 Anderson Rd., McLean VA 22102; **CompuServe (MicroNET),** 5000 Arlington Centre Blvd., Columbus OH 43220.

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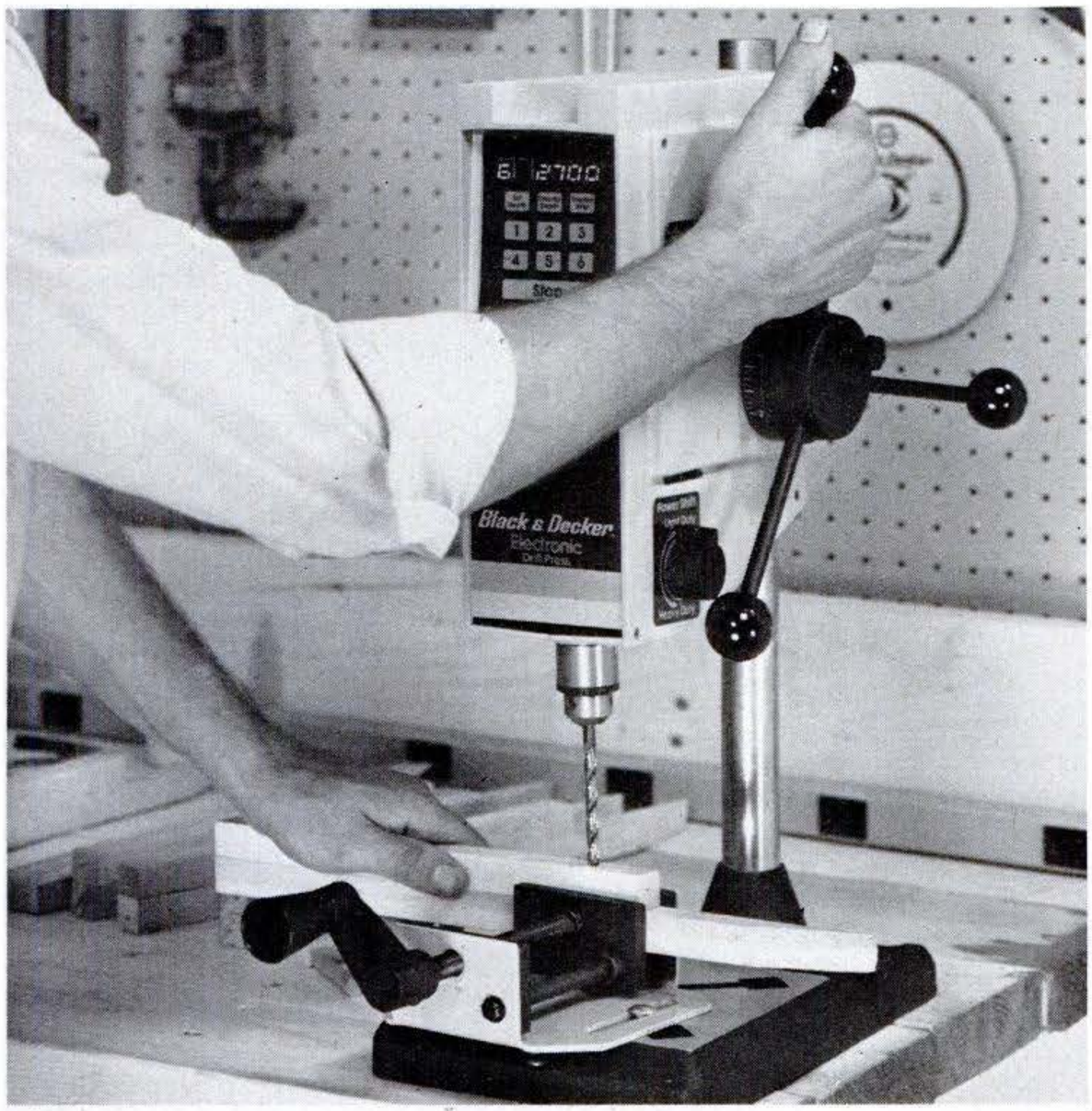
Tools that think

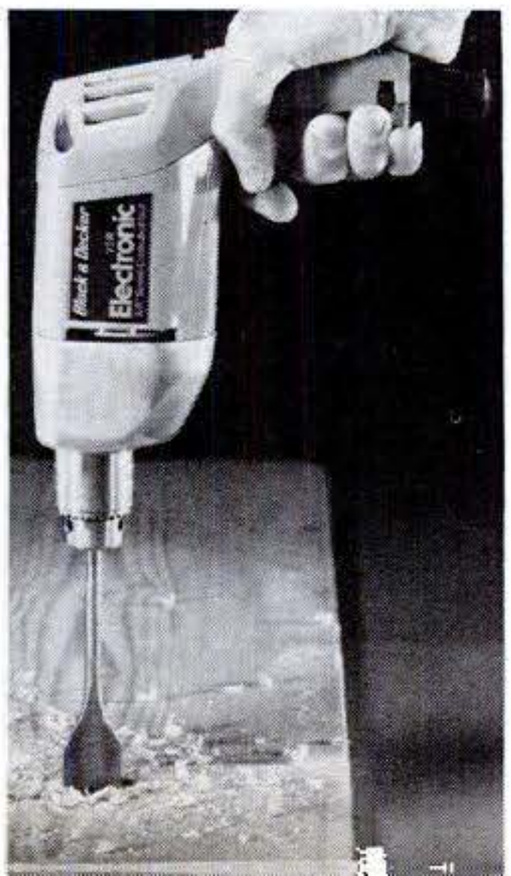
The microprocessor revolution hits your workshop

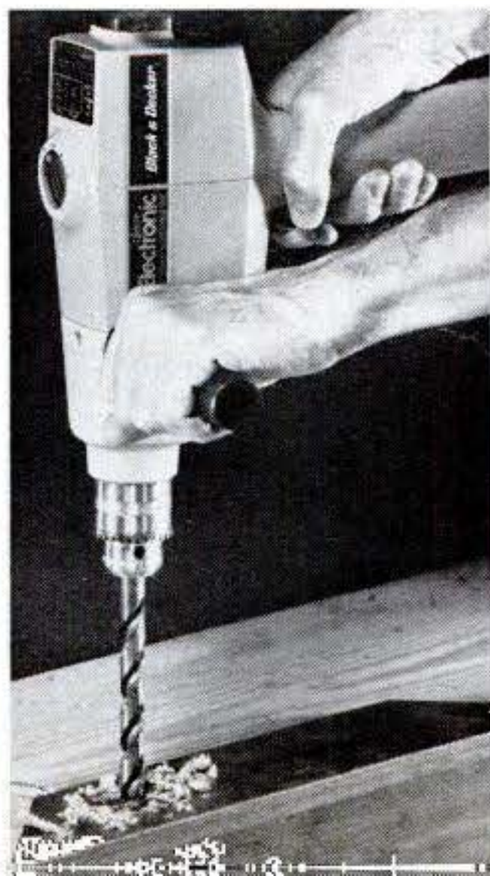
Automatic speed and overload controls plus digital displays are some of their advantages

By RICHARD STEPLER



Electronic drill press (above) displays rpm (shown) or hole depth. Electronics control speed in three portable tools (below, left to right): ⅜-in. drill, scrolling jig saw, and 13-mm (½ in.) drill. All three have detachable 10-ft. cords.





Ever wonder how deep the hole is while you're drilling it? Black & Decker's electronic drill press shows you on a digital display that's accurate to 20 thousandths of an inch. And that's not all this revolutionary bench tool can do:

- Touch a button and the digital display shows speed: 499–900 rpm in the tool's heavy-duty setting, 1200–2700 in light duty. (You select from 12 speeds in all, by pressing the tool's touch-pad controls.)
- A "Speed Keeper" feature maintains a preset speed under varying load conditions. That's because feedback circuits sense when more power is needed.
- "Ramp Speed" gradually shifts speed electronically. That means no jolts to the workpiece when you start a hole or change speeds.
- Use the incorrect speed or improper drilling pressure for extended periods, and the word LOAD flashes on the display, alerting you to a possible motor overload. When an excessive load occurs suddenly, "Power Halt" shuts off the tool automatically.
- The electronic drill press doesn't forget, either. The microcomputer remembers and displays the last speed used when you've finished.

Price of the model 9413 drill press will be in the "$180–$200 range," according to a Black & Decker spokesman. You'll see it in stores beginning in January 1981. (And watch for a test report in a future issue of POPULAR SCIENCE.)

The drill press isn't the only innovative tool from Black & Decker this year. The company also offers three portable power tools that use electronics to make them smarter.

- A 13-mm (½ in.) reversing drill has all the features of the drill press, except speed and depth display. Its price: $110–$120.
- A ⅜-in. variable-speed reversing drill uses a feedback circuit to increase or decrease power to maintain rpm under varying loads. Price of the tool (which B&D could have called a 10-mm drill but didn't): about $50.
- And a variable-speed scrolling jig saw also automatically compensates for varying loads as you're sawing. Price: about $80.

Manufacturer's address: Black & Decker, 701 E. Joppa Rd., Towson, Md. 21204. PS

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What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS

Truck airfoil

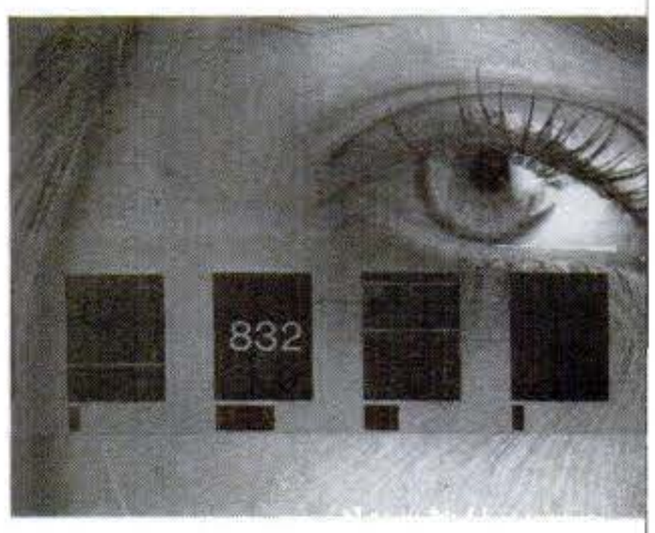
Kinfoil doesn't push air aside like other truck airfoils, says Diversco, Inc. (Box 2748, N. Canton, Ohio 44720). The device's air outlets are smaller than the inlets, creating a high-velocity air screen that reduces drag and boosts mpg, the firm says.

Le Turbocar

Le Car becomes Le Turbocar. This 160-hp turbocharged version of Renault's best-selling R5 sells for about $29,000. The two-seater accelerates to 60 mph in about six seconds. Top speed: 124 mph. Fuel economy is said to be 31.4 mpg at a steady 55 mph.

Noise shield

Plastic noise-barrier panels shield German homes from traffic noise on nearby highways. The polyester-resin panels, reinforced with glass fiber, have good sound-absorption properties and resist weathering, according to Bayer AG, Leverkusen, West Germany.



Microfilm indexer

Three sizes of marks that are applied to microfilm edges as documents are recorded can make retrieval of information more efficient, says Kodak. To retrieve a document at high speed, an accessory to Kodak's 750 microfilmer system counts the marks and stops at the image.

Porsche turbo

A beefed-up two-liter turbocharged engine in the Porsche 924 Carrera GT hot rod delivers 210 hp—40 percent more than the normal European version—for 150-mph-plus capability. Fatter tires help handle the power, while a new front airfoil contributes to the car's 35-mpg economy.

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Reflective tape

Jogging at night? You'll be more visible to motorists with Relexite trim on your warm-up suit. The highly reflective add-on material, introduced by Pilgrim Industries, is available in 10 "fashionable" colors. Pilgrim made the woman's two-piece suit; Loom Togs made the man's.

Royal hydrofoil

HMS Speedy, a hydrofoil built by Boeing for the United Kingdom's Royal Navy, started North Sea patrol duty in June. The vessel, a spinoff of passenger hydrofoils [WN, Dec. '75], has low-speed diesel engines, plus gas turbines for foil-borne speeds of up to 50 knots.

Exercise wheel

Walk on water or roll across snow or sand as you exercise with a Wonder Wheel. The 94-in.-high wheel has dual rubberized-nylon fabric inflation chambers. Price range: $695–$725. Tryton Inc., 300 E. Pleasant St., Churubusco, Ind. 46723.

Power glider

The Gypsy is a powered glider you assemble from a kit in 100 hours, says Weedhopper of Utah (Box 2253-A, Ogden, Utah 84404). Its 25-hp Chotia engine weighs just 32 lbs.; total aircraft weight is only 165 lbs. A kit for the single-seat Gypsy is $2995.

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What's New IN PHOTOGRAPHY

BY E. H. ORTNER

Fast focuser

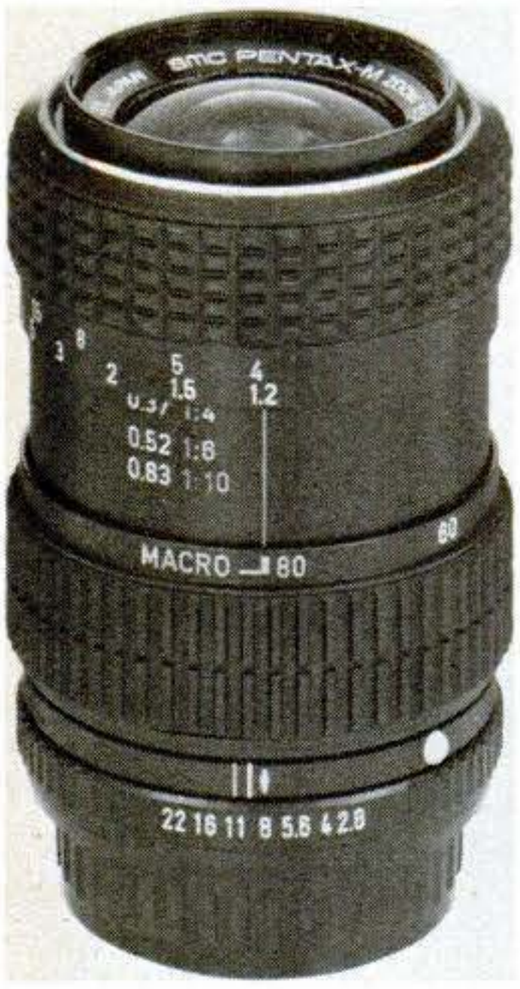
The squeeze-release fast-focusing Novoflex is back on the U.S. market again, now in the compact System C version. The German-made 400-mm f/5.6 lens and follow-focus triggered pistol grip are $1350. U.S. distributor is Aetna Optix, Island Park, N.Y. 11558.

Pro bag

All the gear a working pro needs (and can carry) fits into the Tough Traveler Super Pro Bag, made by Simon Associates (1019 Trillium Lane, Mill Valley, Calif. 94941). It holds three camera bodies, eight lenses, accessories, and film. A tripod hangs underneath. It's $110.

Audible timer

The timing's electronic with the Omega CT-20 audible enlarging darkroom timer—with ranges from 0.1 to 99 seconds, and an audible tone signal every second for dodging or burning in. It handles enlargers up to 300 watts, safelights to 100. Price: $69.95.



Super super 8

Special effects such as dissolves, fades, animation, and time-lapse photography, plus a lens with a 15X zoom range (6–90 mm), distinguish the Bauer S 715 XL super 8 sound movie camera. Four motors power it through 28 computer-controlled modes. It's $2497.

Compact zoom

Maximum aperture changes with focal length in the new SMC Pentax 40–80-mm zoom lens: It's a fast f/2.8 at 40 mm, f/4 at 80 mm. A macro setting gives it close-up capability. The lens weighs 13.9 ounces and measures three inches in length. List price: $260.

72-frame processor

Now that Ilford offers a 72-exposure 35-mm b&w cartridge ["Viewfinder," Aug.], how do you process it? With Ilford's plastic Autowinder reel ($8.90), which fits any standard Nikor-type tank, or with Ilford's stainless-steel reel ($18) and crank-operated film loader ($41).

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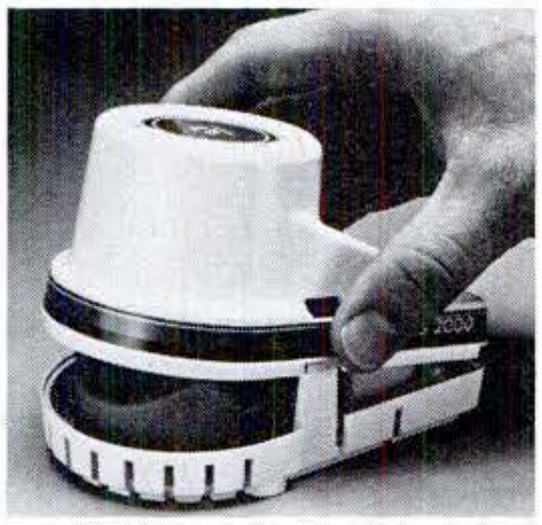
What's New IN BOATING

BY SUSAN RENNER-SMITH

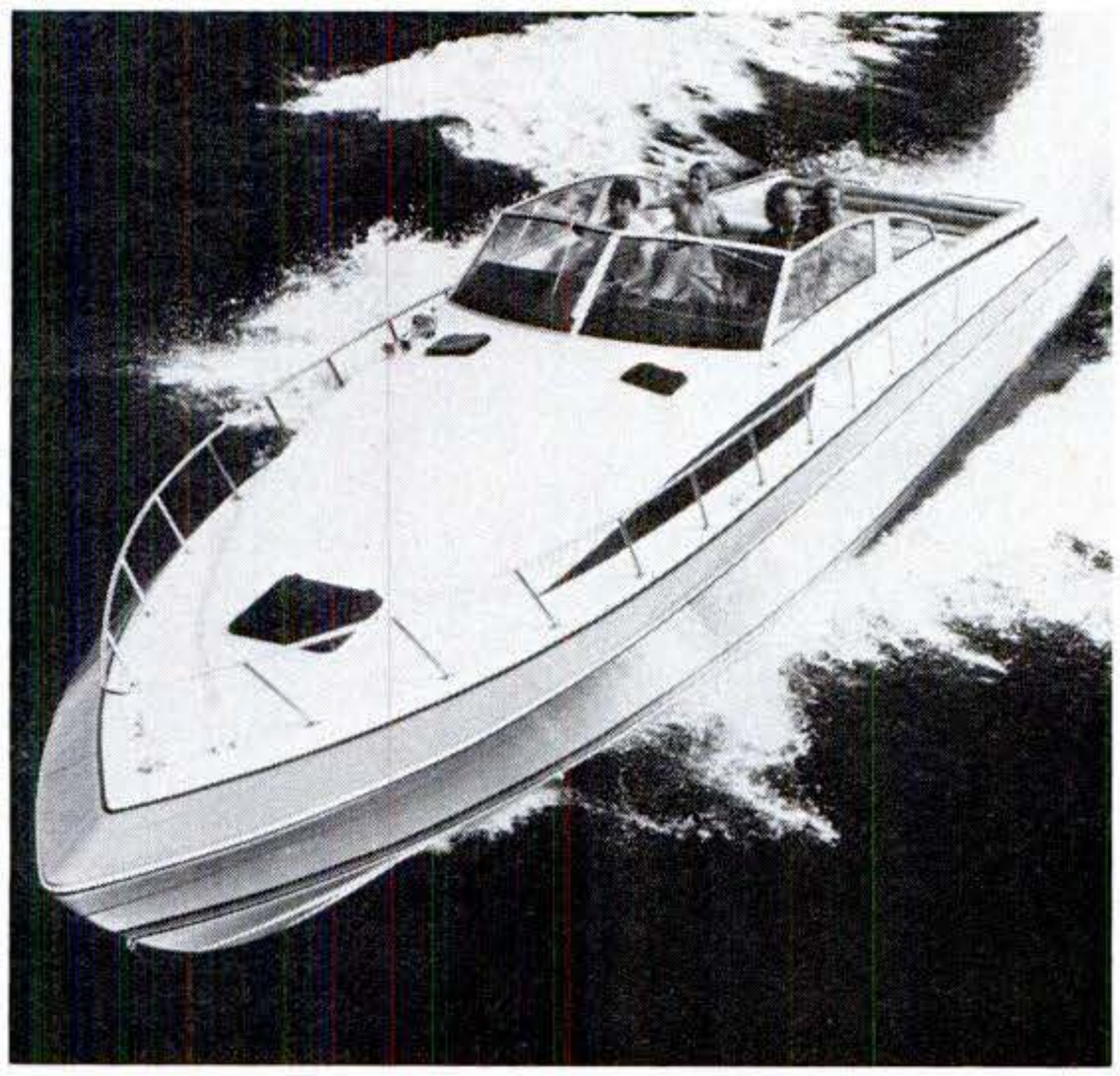


Tilting floater

A stable float switch, the AFS 2000 runs your bilge pump without false starts—even if the switch is tilted at a 35-degree angle, says Atwood Corp. (Box A, Lowell, Mich. 49331). The secret: a heavy-duty lever sealed against moisture and shock. Price: $22.

Classy cruiser

Can high performance mate with cruising comfort? The new 530 has both, says Pearson Yachts (Portsmouth, R.I.). The swift 53-footer has a lightweight, balsa-core fiberglass hull. Its spacious quarters have two staterooms with private heads. Price? $225,000 to $275,000.



Sleek speedster

Rather sun than sail? The Formula 402 SC 1 has a large recessed sun deck aft. The 42-footer carries twin 100-gallon fuel tanks for its two MerCruiser 330-hp engines. Foam construction boosts hull strength—and damps sound, says Thunderbird. Price: $60,000–$80,000.

Collision computer

Hit or miss? To find out, night-cruising skippers enter color and direction of boat lights spotted. The Convergence Indicator analyzes lighting combinations and calculates the sighted vessel's course. Erwin, 6715 Riverside Dr., Powell, Ohio 43065. $299.

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What's New IN TOOLS

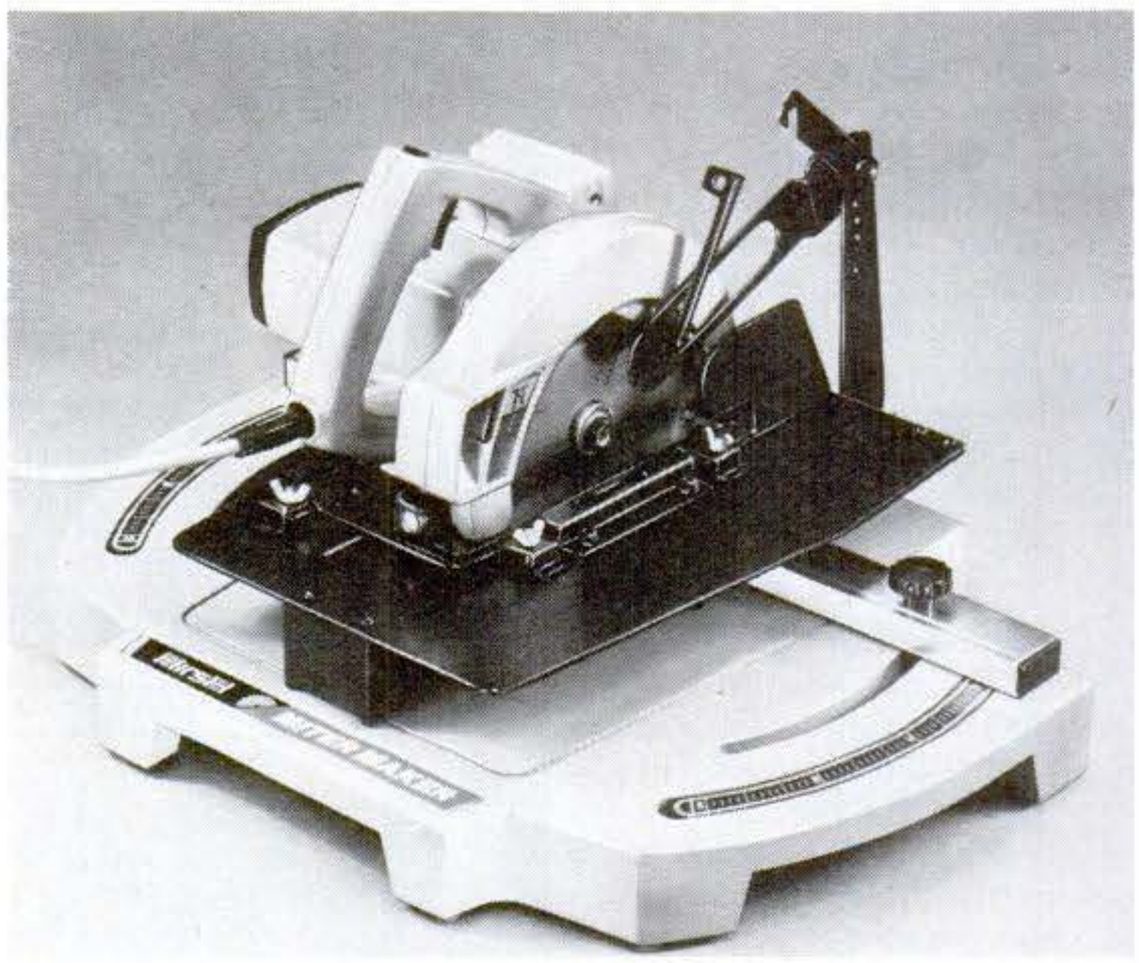
BY PAUL BOLON

Glue

Thirty-minute clamping produces full-strength joints with UGL's new woodworking glue, the maker says. Maximum strength is achieved with overnight drying. It's nonflammable and releases no harmful fumes, claims UGL. Price: $5.30 per quart.

Light wedge

Woodpopper 1 weighs just 20 oz. and splits wood with less effort than other wedges, its maker claims, by absorbing less sledge impact. It's made of machined 2024 aluminum and guaranteed for three years. Price: $17. Giesler Engineering, Box 80, Lenni, Pa. 19052.

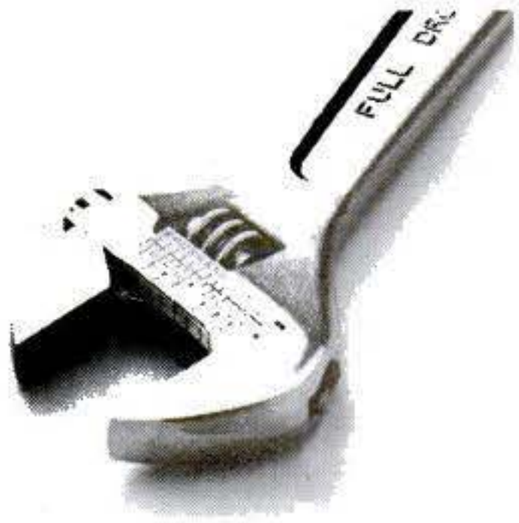


Blower/vac

An accessory vacuum tank on HMC's Yard Blower converts it to a sweeper for yard or shop. A new speed control adjusts air volume for flower beds or piles of leaves. The Blower costs about $55; the vacuum is $35. Maker: HMC, 20710 Alamer a, Long Beach, Calif. 90810.

Metric label

Confounded by metrics in the shop? These pressure-sensitive stickers have millimeter and inch scales. Apply one to an adjustable wrench, and you can quickly gauge drill bits, nuts, and bolts. Three label sets cost $2 from Emeth Equity, 400 Penn Center Blvd., Pittsburgh, Pa. 15235.



Miterer

You can drop your portable circular saw (7-8¼ in.) into the Miter Maker and make accurate corner cuts. The plastic frame accommodates most saws and miters stock up to 2½ in., with a 3⅝-in. cutoff limit. Price: $45. Maker: Hirsch, 8051 Central Park Ave., Skokie, Ill. 60076.

Pump

Powered by any 12-V supply, the 18-oz. Handi-Pump pumps up to 30 gal./hr., says its manufacturer. The pump kit includes 10 ft. of plastic hose and lead wire. Price: $34.95. Maker: Facet Enterprises, Auto Components Div., Elmira, N.Y. 14903.

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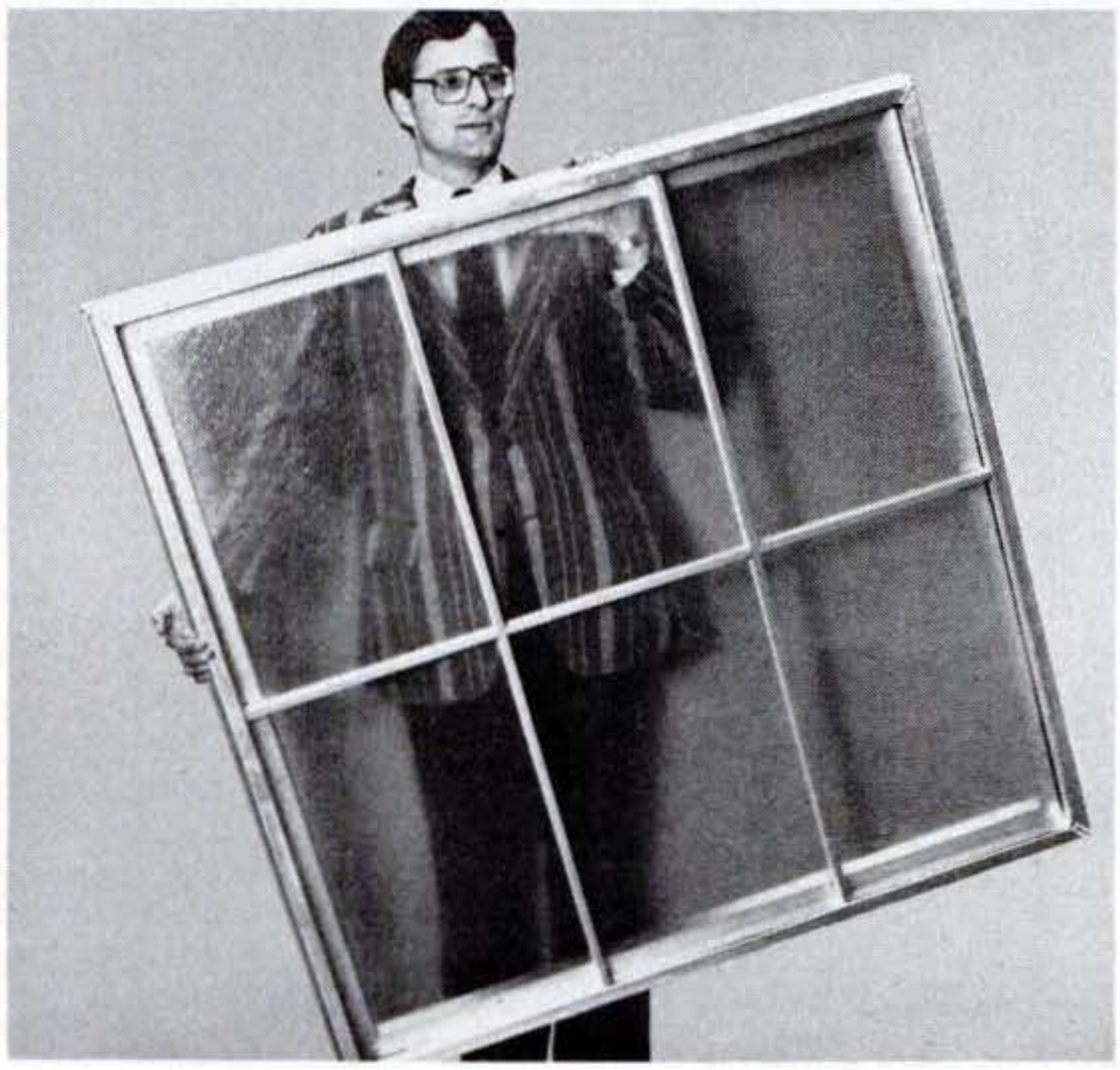
What's New IN HOME IMPROVEMENT

BY PAUL BOLON

Sealant

Geocel seals windows, doors, or basement walls. The manufacturer (Geocel, Box 398, Elkhart, Ind. 46515) claims its copolymer base remains more flexible than silicone, adheres to wet surfaces, and is a good emergency gasket material. Price: $4.09 per cartridge.

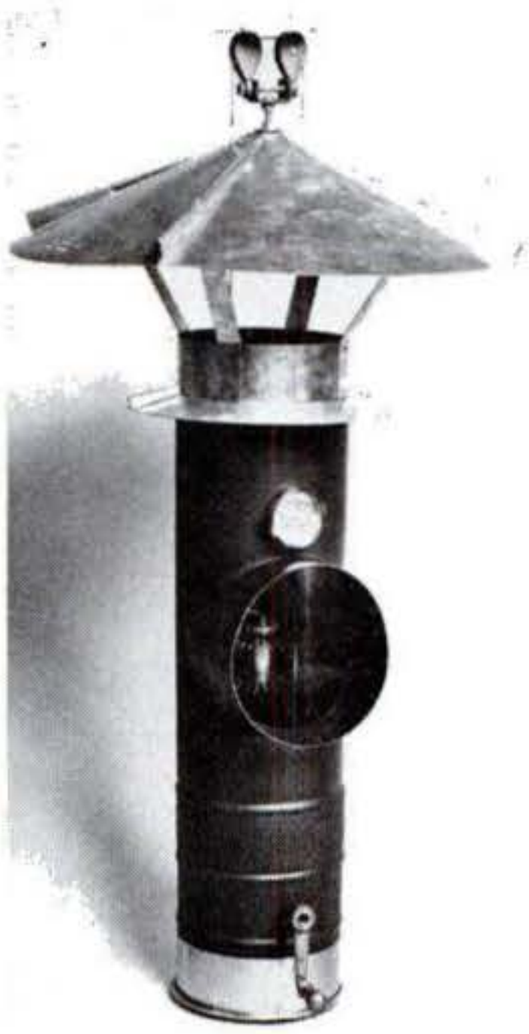


Skylight

Impact-resistant fiberglass double glazing and aluminum frame give Sun-Lite skylights long-term, low-cost maintenance, claims the maker (Kalwall, Box 237, Manchester, N.H. 03105). Solar transmission is said to be 77 percent, with thermal resistance (R-value) of 2.2.

Central thermostat

The Master Energy Management Panel controls temperature setback for up to 10 individual room thermostats for electric-heated homes. The panel can also regulate air conditioning, water heaters, and lighting. Price: $260 from Therma-Ray Mfg., Box 516, Old Saybrook, Conn. 06474.



Chimney sweeper

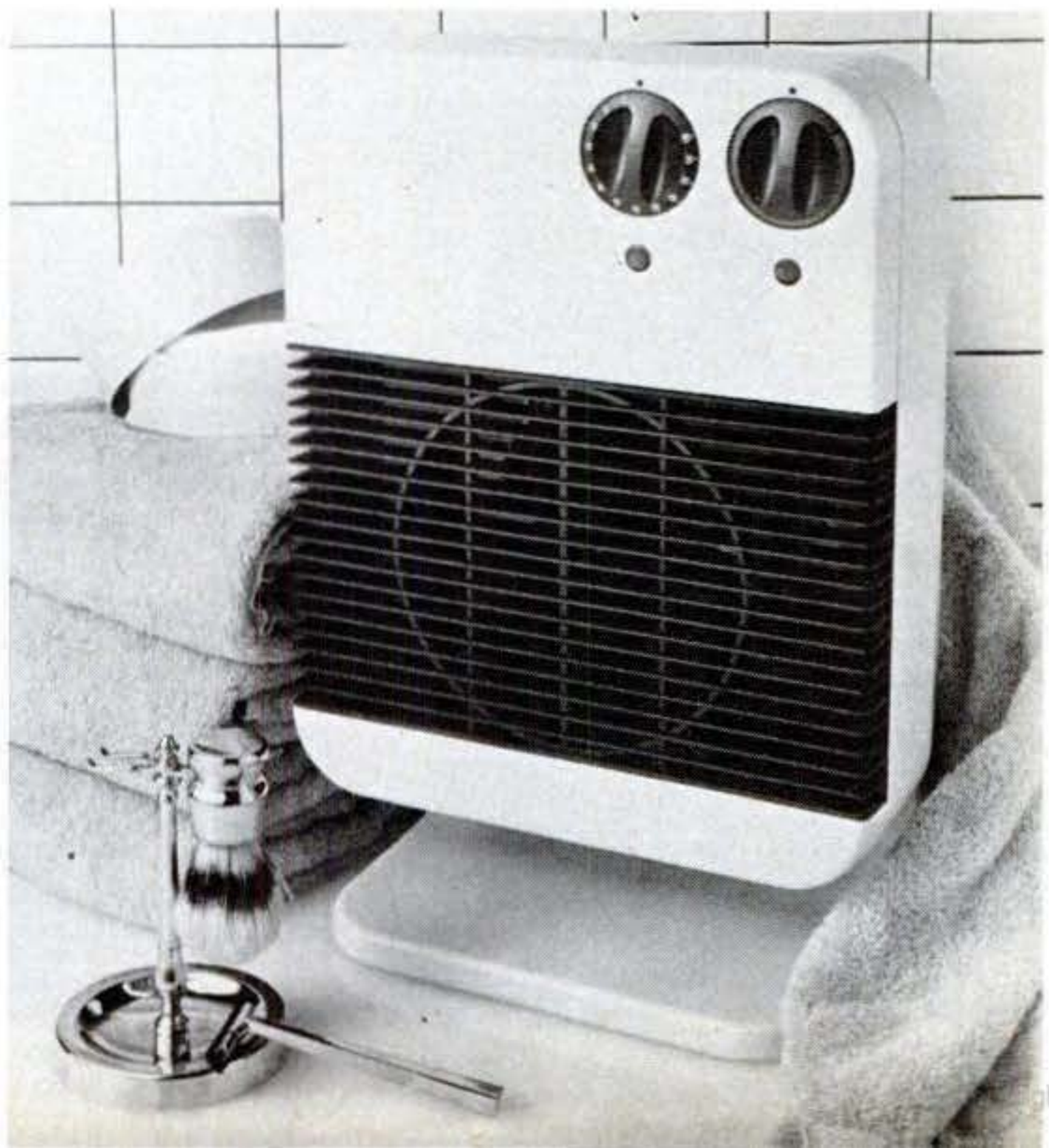
T-fitting of Boz sweeper houses circular wire brush that cranks up and down on cable to clean metal pipe flues. T-fitting replaces elbow at flue bottom. Unit for six-in. flue up to 17 feet tall costs $139 from Boz, 5500 Pierce Park Lane, Boise, Idaho 83703.

Oil meter

Fuel Minder's digital display will read out oil consumption in dollars or gallons while the burner is on, says the maker, or even keep track of season total. It requires no electrical or plumbing connections on burner. Price: $59.50 from Crestline, Box 127, South Walpole, Mass. 02071.

Portable heater

Krups' portable fan heater has five thermostat settings to regulate either 750-W or 1500-W output. The timer sets a single heating cycle up to 60 minutes long. An antifreezing control turns the heater on if room temperature falls below 36 deg F. Price: $100.



Air cleaner

Airmax's electronic air cleaner removes 90 percent of airborne particles and can be installed by homeowners, says the maker (Airmax, 6850 Wynnwood, Houston, Tex. 77008). It runs on house power and cleans up in water. It's also UL listed. Cost: about $250.

What's New IN ELECTRONICS

BY WILLIAM J. HAWKINS

Built-in tape

The Onkyo CX-70 is an AM/FM receiver with a difference: Behind that pop-out drawer (inset) there's a metal-tape cassette player, making it a new type of "multi-component" unit. With Dolby, timer-start, and mike mixer, it's $399.95.

Hat for runners

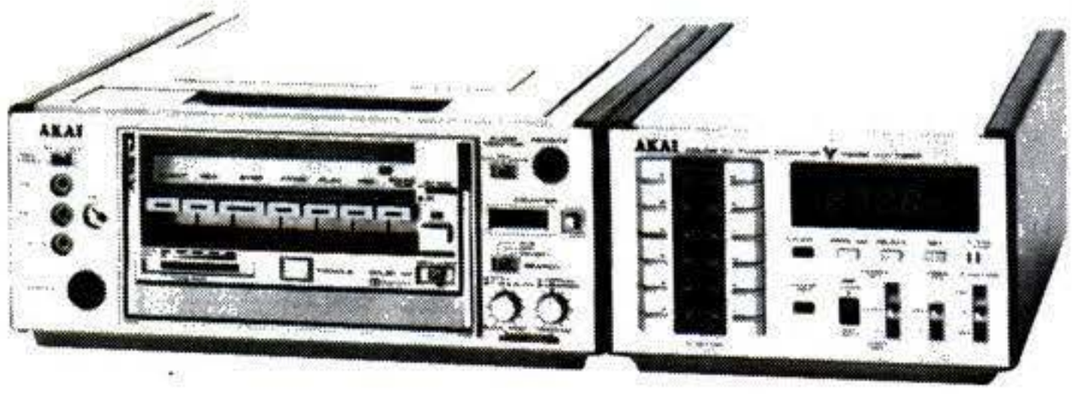
If you're tired, stop jogging. But if you're just tired of jogging alone, put on the Radio Hat from Edsujo Inc. (3716 Waverly Ave., Seaford, N.Y. 11783). News, weather reports, or music plays through an earpiece to keep you company. Weight: 7.5 oz. Price: $15.90.

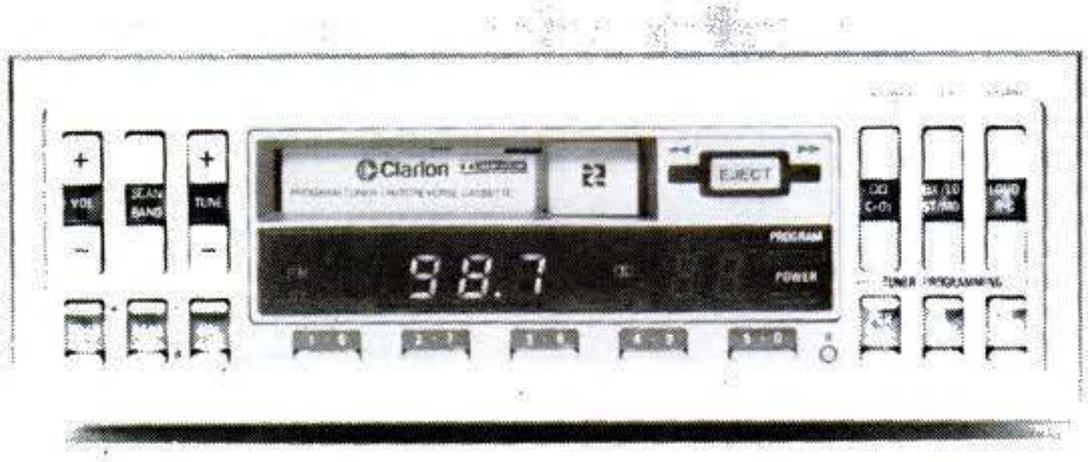
Three computers

Take your pick (clockwise from bottom): On the go, use Radio Shack's Pocket Computer ($249). At home, the Color Computer ($399) accepts your programming or preprogrammed cartridges. And for the office, the Model III controls up to 345K of memory ($699–$4000).

Two-channel audio

It's not what you see that makes the Akai ActiVideo VHS video recorder so different—it's what you hear. The deck records two separate audio tracks. Use it for taping in stereo or for recording tapes with a bilingual sound track. With tuner, it's $1595.





Sounding off

Program sound effects, music, or even a voice on this new Ohio Scientific computer (1333 Chillicothe Rd., Aurora, Ohio 44202). It's BASIC language makes it easy—its basic price makes it possible: $479 (8K RAM, disk available).

Smart car radio

Don't push the buttons on Clarion's car AM/FM cassette player—it automatically picks and plays up to 10 different stations for you. A programmable memory holds the frequency of your favorite station and the time at which you'd like to hear it. The PE-959 is $899.95.

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What's New
FOR YOUR CAR

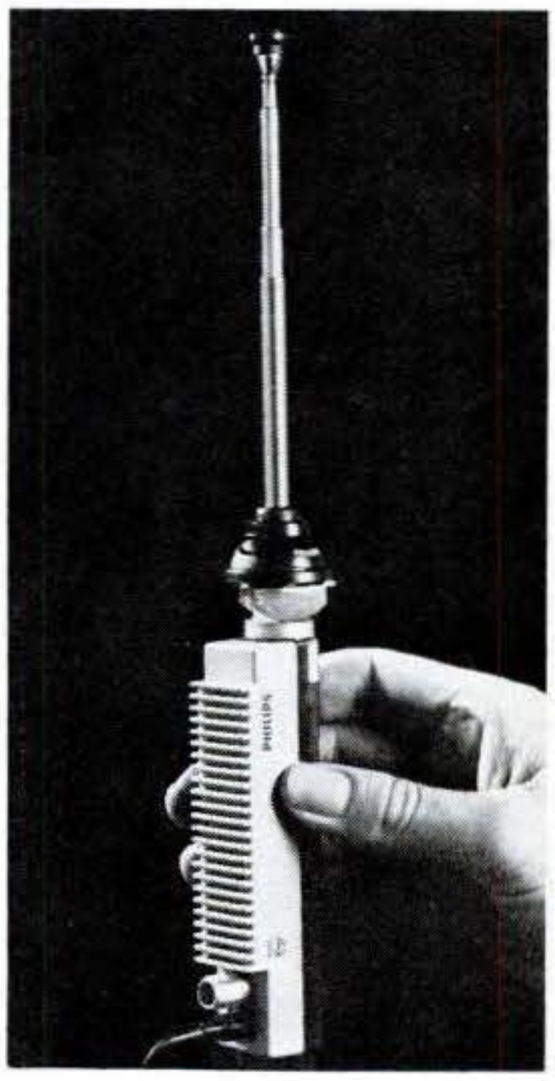
BY ED JACOBS

Emergency light

Streamlight's SL-20 20,000-candlepower rechargeable flashlight has a fully machined extruded-aluminum case, Lexan lens, and quartz-halogen bulb. It's $95, with charger and nicad batteries. Streamlight, Inc., 1030-P W. Germantown Pike, Norristown, Pa. 19403.

Back massager

Plug Driver Reviver into your vehicle's cigarette lighter, slip the cushion behind your back, and you'll get a fatigue-relieving massage, according to G2 Enterprises, Inc., 255 W. 90th St., New York, N.Y. 10024. An extension cord allows rear-seat use. Price: $32.50.



Amplifying aerial

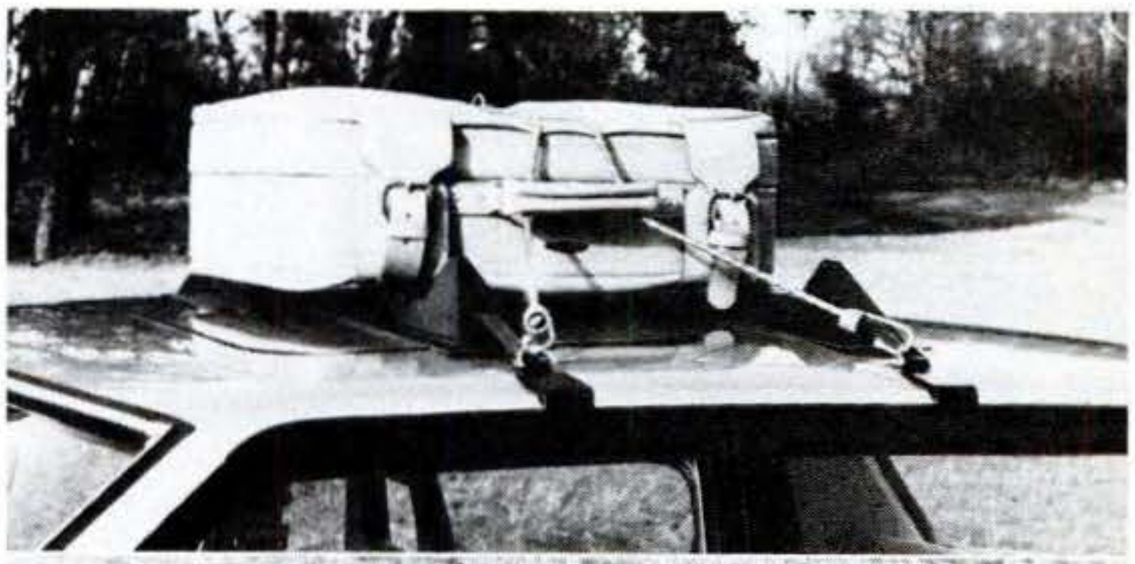
A preamp in the base of this antenna improves the signal-to-noise ratio and reduces cross modulation, says its Dutch maker. It comes in 16-in. manual or 39-in. power-extended models. Philips Gloeilampenfabriken, Car Radio Dept., Building SFF2, Eindhoven, Holland.

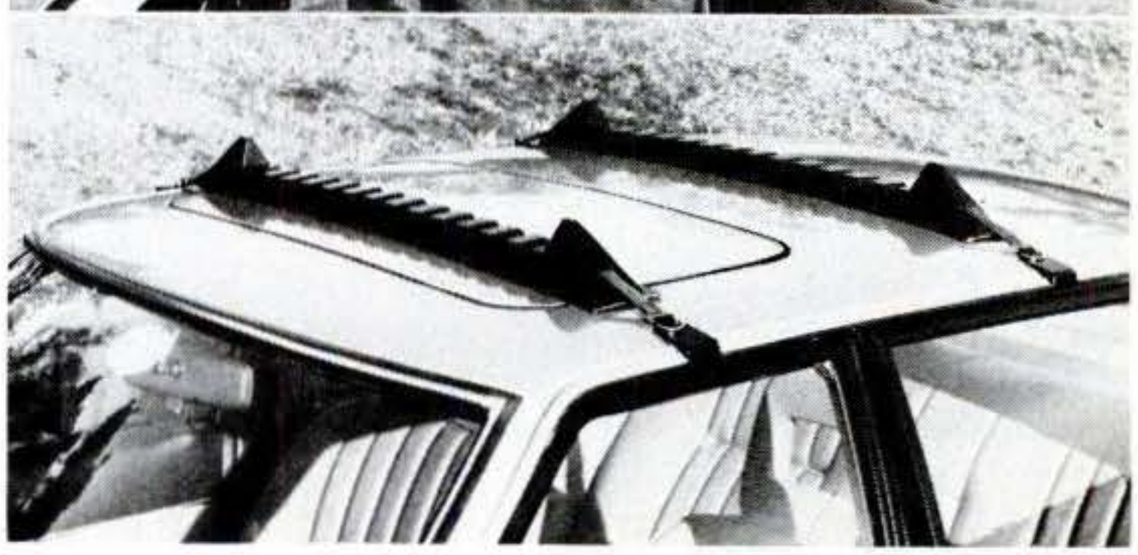
Buffer/polisher

The Craftsman buffer/polisher's elliptical action is said to prevent swirl marks and burns. The two-speed unit is designed for polishing chores, wax application, and buffing. With three buffing pads, it costs about $60 from Sears.

Instant rack

The flexible plastic load bearers of this carrier mount on your roof or trunk at the spacing your load requires. Adjustable straps hold them on; D-rings secure your cargo. Autolux Accessories, 33 Hallgate, Doncaster, S. Yorks., EN1 32T, England.





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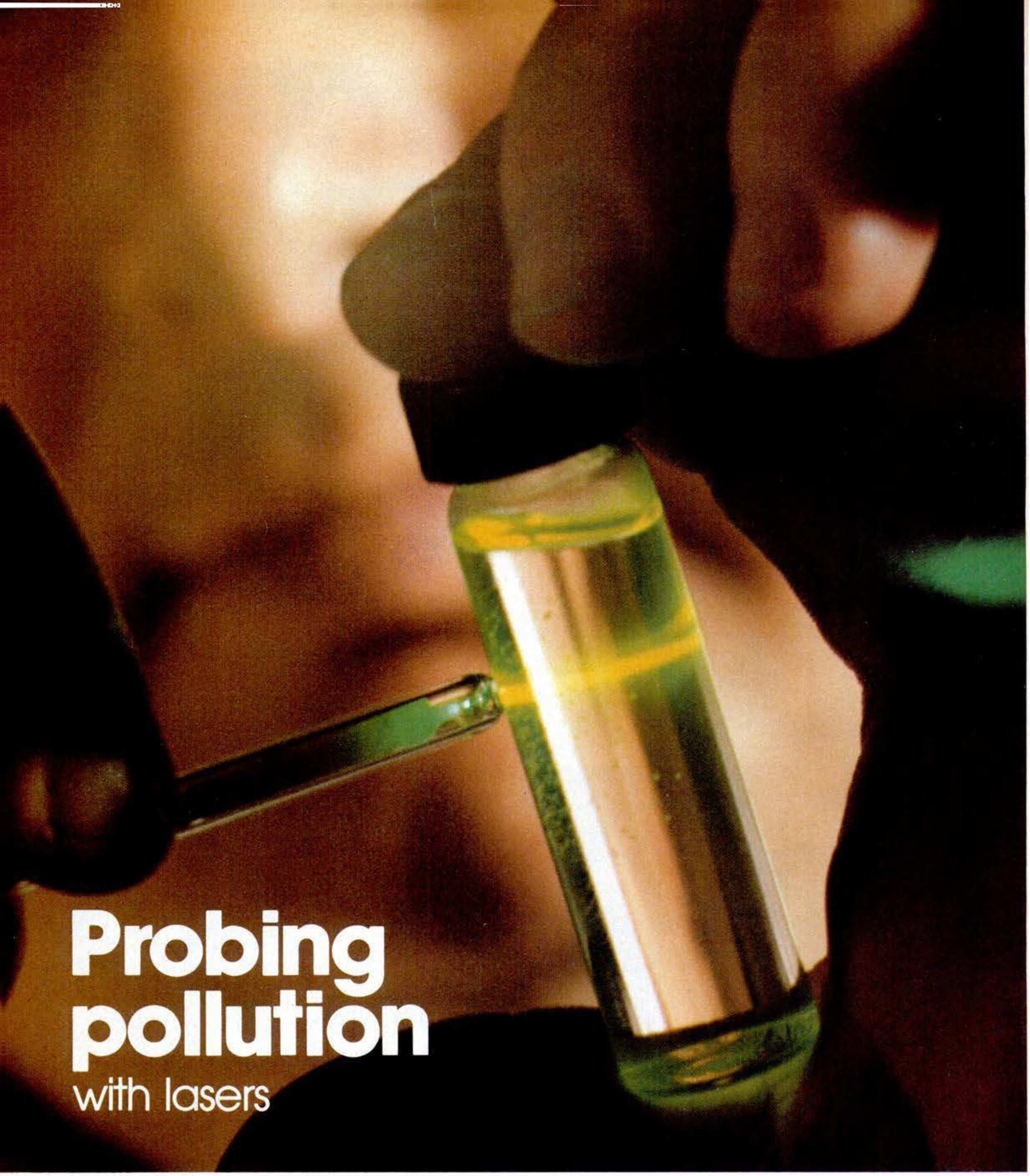

Probing pollution with lasers

By ARTHUR FISHER

Problem: Suppose you had to analyze the stuff spewing out of a dozen smokestacks all at once, all situated within a one-mile circle, but couldn't afford to install monitoring equipment at that many sites?

Solution: Just use one analyzer at a central lab, and connect it to the remote sites by an ingenious system of light pipes carrying laser beams.

The new system, called a Remote Fiber Fluorometer (RFF) has been developed by a team of chemists headed by Dr. Thomas Hirschfeld at California's Lawrence Livermore National Laboratory. A single RFF can measure pollutants in samples up to a mile away, replacing a multitude of expensive instruments, with a potential saving to government and industry of millions of dollars. It works like this: Laser light speeds down a glass optical fiber from the central lab to the specimen being sampled. It causes the specimen to fluoresce, as in the photo. The fluorescent glow travels via fiber back to the lab, where instruments determine the nature and concentration of a chemical from the color and intensity of the light emitted.

Besides monitoring pollution, the remote system could be valuable anywhere chemical analysis is needed in a hostile environment, for example, inside the radioactive core of a nuclear reactor. PS

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Ready your snow thrower
to get the jump on winter

Follow these expert tips and be set for early storms

By E. F. LINDSLEY

Approaching winter with the assumption that you can just fire up your snow thrower when the first snow falls could net you a rude surprise. Here are pre-season service tips from my experience, plus advice from Jacobsen experts.

Before doing anything, carefully read your owner's manual. Become thoroughly familiar with controls and operating procedures—especially how to stop the unit and disengage the drive and augers or paddles.

Now give your machine a complete inspection. Be certain that everything rotates freely, that there are no broken or damaged parts, and that all controls are properly adjusted and operating. Make sure that shear bolts, engine-mounting bolts, and other fasteners are properly tightened, and be certain that the engine-stop circuit is intact. Don't overlook interlocks.

Proper lubrication is important before and during the season. Apply general-purpose grease to the discharge-chute sliding area, chute-retaining washers, sprocket, sprocket bearing, universal joint, and traction-drive gears. When remounting or replacing collectors, remove and coat the collector shaft, bushings, and inside cups of the retainers. Reinstall carefully.

Apply SAE 30 oil to pivots for the speed-control arm, traction-clutch rod, speed-control linkage, traction clutch and springs, impeller-collector clutch and springs, and idler pulley. Lube the throttle cable by dropping oil along the conduit or rubbing with an oil-saturated cloth.

On a four-cycle engine, check the crankcase-oil level. On a two-cycle engine, you must premix oil and gasoline—a *two-cycle* oil, though; automotive oil is certain to cause trouble. Check your manual for oil quantity, type, and change interval.

To prevent snow and ice buildup on moving parts, spray wax or silicone inside the collector housing, impeller-discharge chute, and deflector.

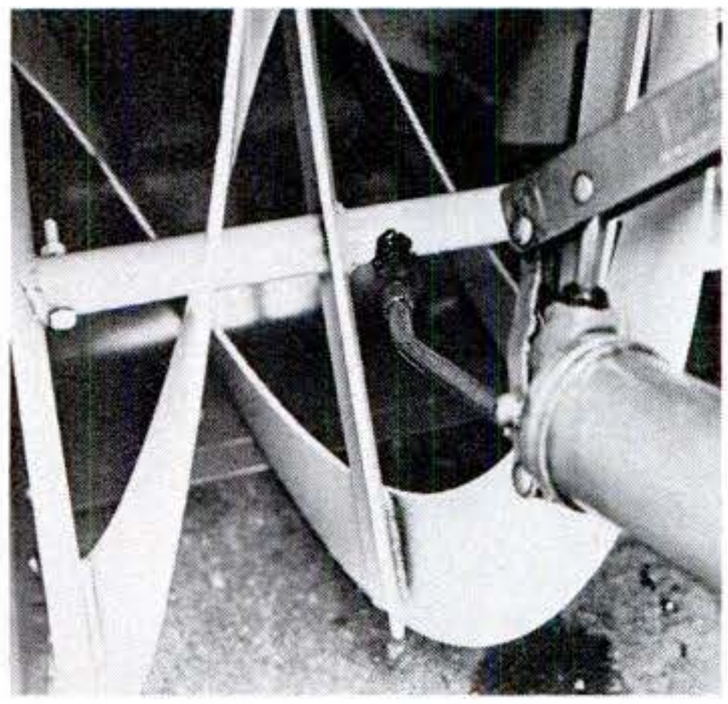
If you left fuel in the machine last winter, remove it, flush out any residue with fresh fuel, and try to start the engine. If it won't start or cuts out, your carburetor and fuel screens and strainers may be gummed up. If you're not a mechanic, see your dealer.

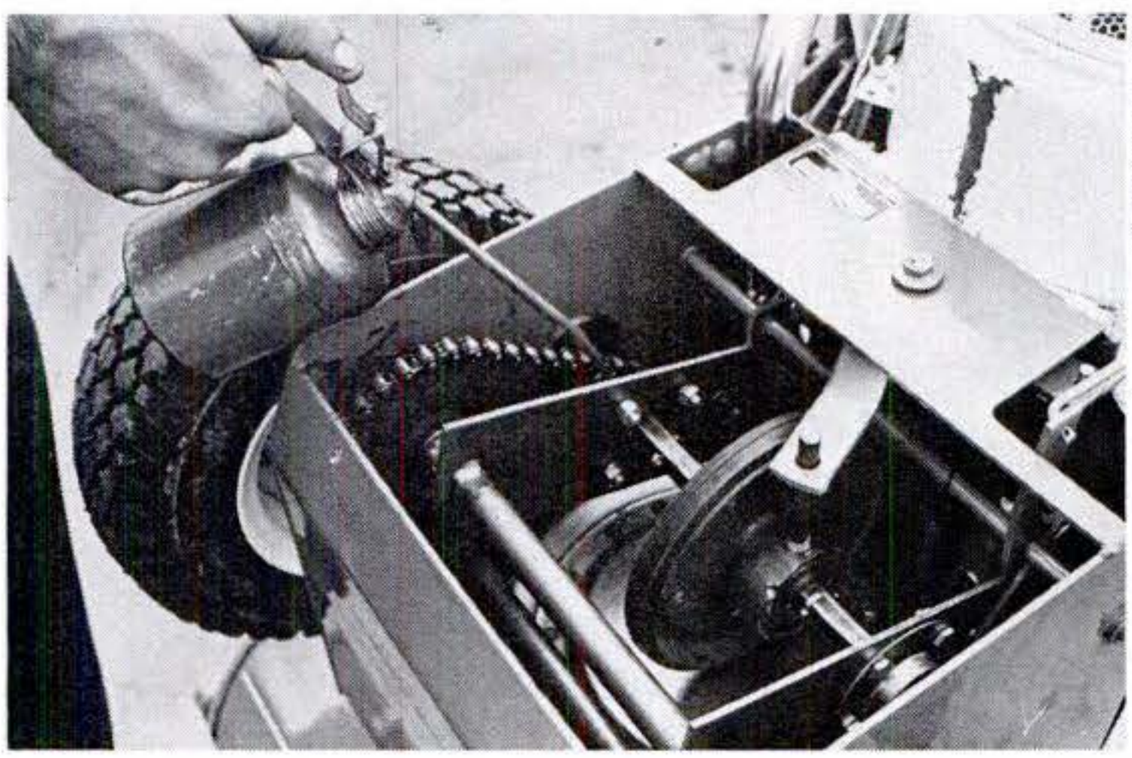
Even if the carburetor is perfect, the engine won't start without a healthy spark. Remove the spark plug, reconnect the high-tension lead, and rest the plug so it contacts bare metal on the cylinder head. With the ignition on, you should get a good spark when you crank the engine. If you get no spark, be certain you're not overlooking an interlock. If the plug looks worn or fouled (see photos), install a new one of the proper type (check your manual). If that doesn't cure the problem, see your dealer.

Fuel carefully with an approved container—outdoors and never while smoking—and wipe up any spilled fuel. Never add fuel to a hot engine.

When the engine is running well, check all controls for smooth, positive action. Where controls tighten a drive belt, a simple screw adjustment in the control rod will tension it properly. (Remove the spark-plug wire before any maintenance.) If the belt is cracked, glazed, or frayed, get the correct replacement, not a fractional-horsepower type.

Now that you're ready to go, inspect the work area; remove all foreign objects, and mark hidden obstacles. Disengage all clutches and shift into neutral before starting. Use a grounded three-wire outlet for electric drive units or starters. Never use a three-prong "cheater" plug. PS





Adjust height of collector housing to clear gravel, crushed stone, or rough surfaces by placing on a board and lowering skids (top left). Grease collector shaft to prevent rusting or binding (top right). Apply SAE 30 oil to drive-chain side plates until it soaks each roller and shaft (as with Jacobsen at lower left). Particles bridging spark-plug gap (middle right) can prevent starting and must be cleaned away. Replace plugs that have eroded electrodes or heavy carbon deposits (lower right).

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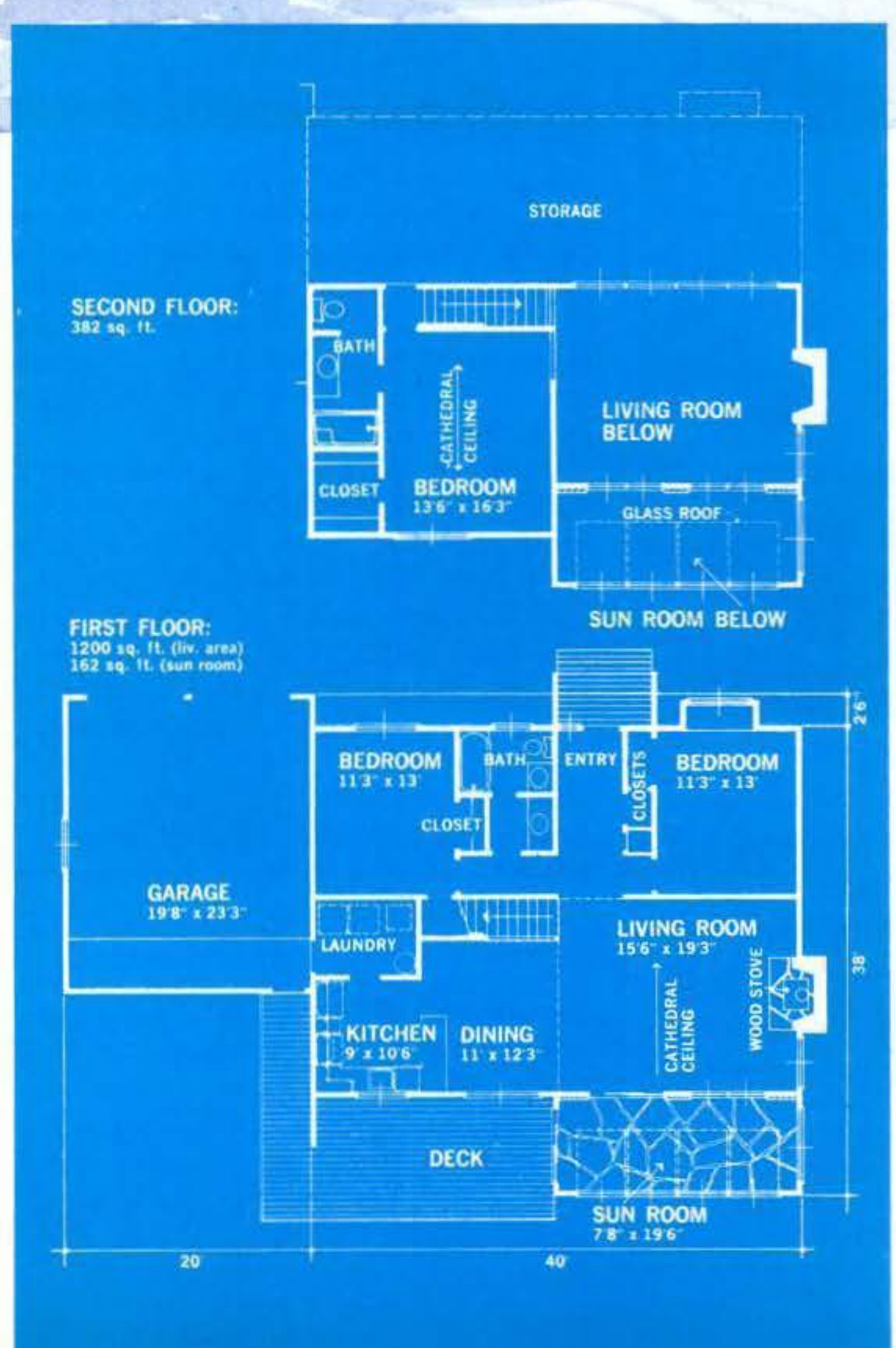

How to order your plans

One set of detailed, professionally drawn blueprints for this house is $95; four sets—for building, financing, and permits—are $140. Specify plan 877-5A (without basement) or 877-5B (with daylight basement). Plans will be reversed for $20; materials list is $15. Home Building Plans Service, 2235 N.E. Sandy Blvd., Portland, Ore. 97232. MasterCard or Visa orders by toll-free call: (800) 547-5570 (plans orders only).

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Sun-room chalet

By AL LEES

Whether you build near the ski slopes or on a lake shore, you'll appreciate this energy-conscious design from Home Building Plan Service, in cooperation with the Western Wood Products Assn. It snugs a sun room next to the living area.

Remind you of the old adage, "There's nothing new under the sun"? The current rage for integral solar bays in new houses echoes past experience with solariums and lean-to greenhouses. Only now we do it to save fuel. As shown in the exterior rendering and the cutaway (both depicting the south face, though from different angles), the sun room is glazed on south and east exposures, with skylights overhead to act as a passive collector. Heat from the warmed air is stored in a masonry floor of field stone or quarry tile. Double-glazed, wood-framed patio doors (set in a masonry partition wall) slide to regulate the flow of warm air into the living area.

Note that this living area can be further warmed by an airtight wood stove, with the flue pipe left exposed for maximum effect of radiant heat. A heat-circulating fireplace could occupy the same space as the stove.

Solid-board paneling and siding take advantage of wood's natural insulating qualities, and substantial wall and ceiling insulation is specified on the plan sheets.

The home's main entry is on the north side. A hall flanked by the downstairs bedrooms and bath leads into a spacious living room with a dramatic cathedral ceiling slanting down toward the glass roof of the sun room beyond. Upstairs, the master bedroom (with its private bath and walk-in closet) overlooks this light-bathed space by means of a railed opening. The master bedroom also boasts its own south-facing window, shaded from high summer sun by a roof projection. There are no windows on the west, only small ones on the north.

The attached garage gives direct access not only to the kitchen, but to the large wooden deck (note passageway at the left in the cutaway drawing). This deck tucks in under the master bedroom and is further sheltered by that roof overhang. PS

Electronic garage lock

you can build in 30 minutes

If you have a garage-door opener, you can gain easy access inside without keys or transmitter. The secret is a small box with 10 push-button switches that can be mounted outside your garage door. When the right buttons are depressed simultaneously, the door will open.

The 10 switches are all either "normally open" types (like most switches) or "normally closed" types. Normally closed switches break the circuit, rather than complete it, when the button is pushed. With a mixture of both kinds of switches, you multiply the odds against picking its code, as with any other lock.

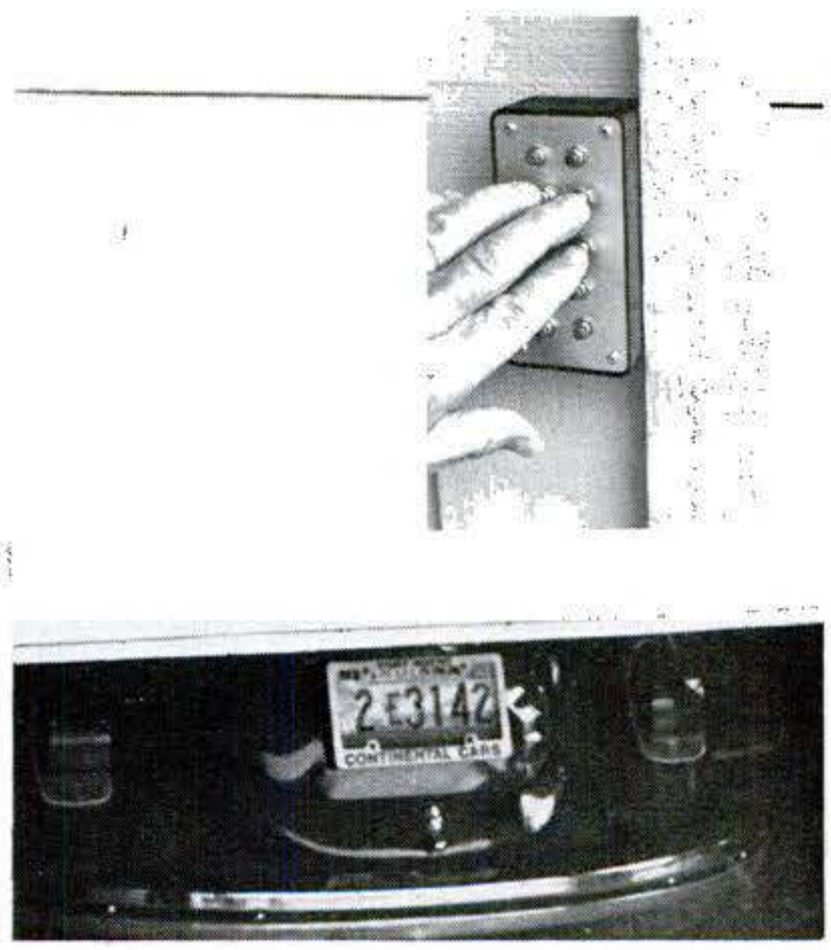
Any metal or plastic box can be used to house the switches. Both box and switches can be purchased at any electronics store.

After drilling holes in the box for switches, you must choose the number and location of the active buttons. The strongest combination for security is five active buttons. But pressing five can be awkward. An ideal combination seems to be three or four active buttons and six or seven normally closed.

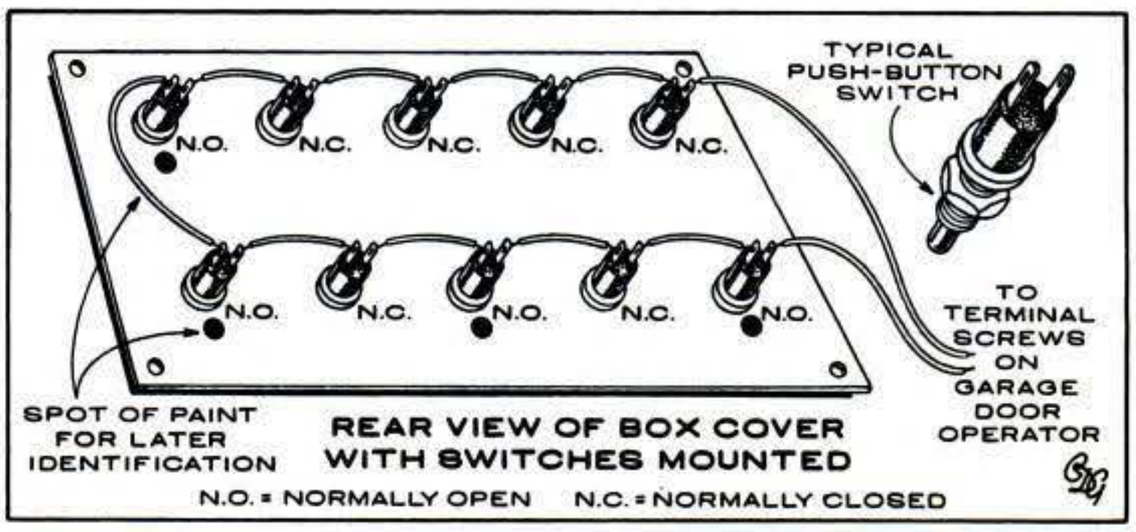
Mount the active buttons on the cover and mark them with a spot of paint on the inside of the box, then mount the remaining switches. Solder bell wire from switch to switch. Drill holes in the box corners for mounting screws, and a ½-in. hole in the back for connecting wires.

Disconnect the power to the door opener and run bell wire from its low-voltage terminal screws to the box. These terminal screws are usually on the rear of the opener with one or more wires already hooked up for inside switches. After connecting the bell wire to the terminals, connect the bell-wire leads to the first and last button switch.

Now turn on the power and test the unit. The door should open as if switched from inside. Finally, mount the box or set it flush to the garage-door casing for more protection.—*Chris Propst*



Electrical push-button lock is mounted in a highly visible position on the door casing. Door opens only if "active" buttons are pushed simultaneously.



All push buttons are wired in series (left) and circuit is completed to terminals of door opener with bell wire. Lock is handy for children since it doesn't need keys. Box can mount flush on jamb for more protection.

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Costly wallcoverings
—how to hang them without goofs

With careful preparation, you can create striking, professional-looking interiors

By SUSAN RENNER-SMITH

"It was agony hanging that foil," my friend said when I complimented him on a handsome dining-room accent wall. "The stuff is scratch-prone, so you can't smooth it down with a wallpaper brush. And," he added, "it's almost impossible to get the bubbles out."

The job would have been easier if my friend had used a lining paper and had "dry-hung" the foil. These are just two of the tricks professionals use to hang expensive, hard-to-handle wall coverings like those listed at right.

A lining paper provides a smoother surface than even perfectly scraped, spackled, and washed walls can offer. Stan Warshaw of the School of Professional Paperhanging in Rutland, Vt., advises hanging the lining paper vertically, using the same adhesive you'll use for the wall hanging. To avoid bulkiness, cut lining paper ⅛ inch short of corners and baseboards and leave 1/64-in. space between seams. Let the lining paper dry at least 24 hours.

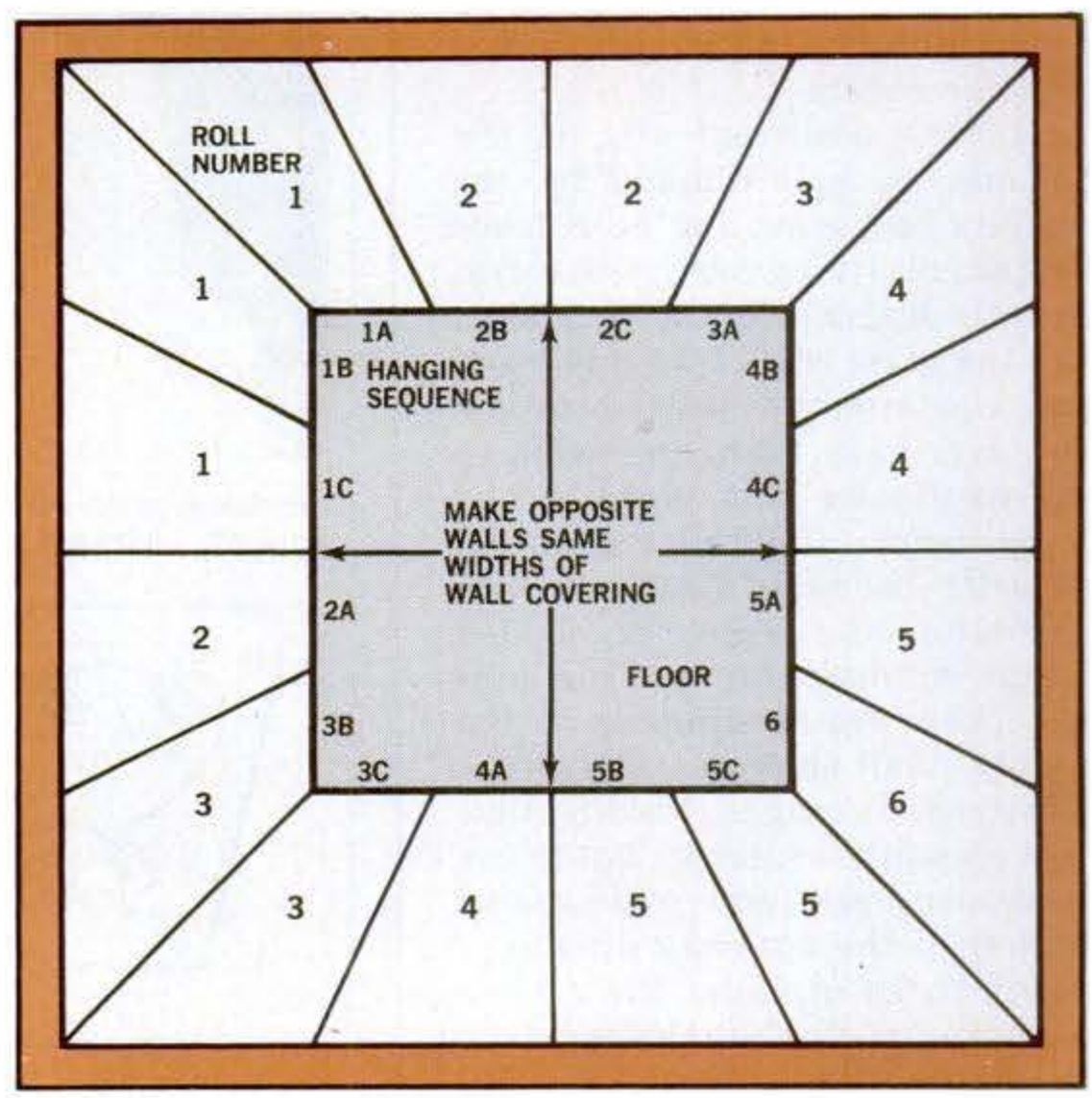
Handling temperamental foils is easier if you "dry-hang" them—that is, paste the wall instead of the sheet. Apply paste to a space as wide as two and one-half sheets, and let it get tacky. Warshaw suggests rerolling the sheet up from the bottom so the top of the roll can be put at the ceiling. Then align one edge with a predrawn plumb line until about three-fourths of the sheet is positioned. Press edges down with a clean seam roller or fingernail. You *can* smooth with a clean, short-bristled brush covered with a damp dish towel to prevent scratches.

What about those bubbles? Experts at Reed Wallcoverings in Atlanta have a simple fix. Poke the needle tip of a syringe into the bubble and inject a small dose of water to

[Continued on page 138]

SPECIALTY WALL COVERINGS	Wall Size				Adhesive			
	Wheat flour base	Cellulose base	Acrylic wallcovering primer	Oil primer-sealers	Wheat paste & cellulose	Fortified wheat paste or cellulose	Premixed vinyl clay or polymer base	White premixed vinyl adhesive
Paper-backed vinyl and Kraft paper	X	X	X		X	X		
Lightweight fabric-backed vinyls		X	X	X		X	X	X
Heavyweight fabric-backed sheet vinyls			X	X			X	X
Fabric-backed foils and flocks			X	X			X	X
Textiles, including felt and burlap			X	X			X	X
Grasscloth	X	X	X		X	X		
Cork (Use a mix of two adhesives)			X	X			X	X

To make sure new covering will adhere smoothly, pretreat walls with a wall size that's compatible with adhesive (see table, above). If there's even a remote chance of mildew, use an adhesive "fortified" with a fungicide. For nonbreathing coverings, such as foil and heavy vinyl, also mix a tablespoon of Lysol into each bucket of adhesive. Adhesive's chemical action may cause flaking or peeling, so avoid getting it on front of material.



Grasscloth-covered walls won't have startling shading differences if you follow the hanging sequence in the diagram at right. First examine the run or shade numbers on each roll. If these are different, arrange rolls in order, from lowest to highest number. Cut a sheet from the first roll and hang it at an inside corner. Hang the next two sheets from this roll on the adjacent wall. Then hang two sheets from roll number two next to the single panel from roll number one. Continue in the order shown. The colors on the walls will blend together, even if there are subtle variations between sheets.

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Slick, foil-covered walls look professionally papered, but were installed by a careful amateur. Meticulous wall preparation—scraping, washing, smoothing—is essential before hanging difficult and expensive wallcoverings such as foil.

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Post lamp and mail center

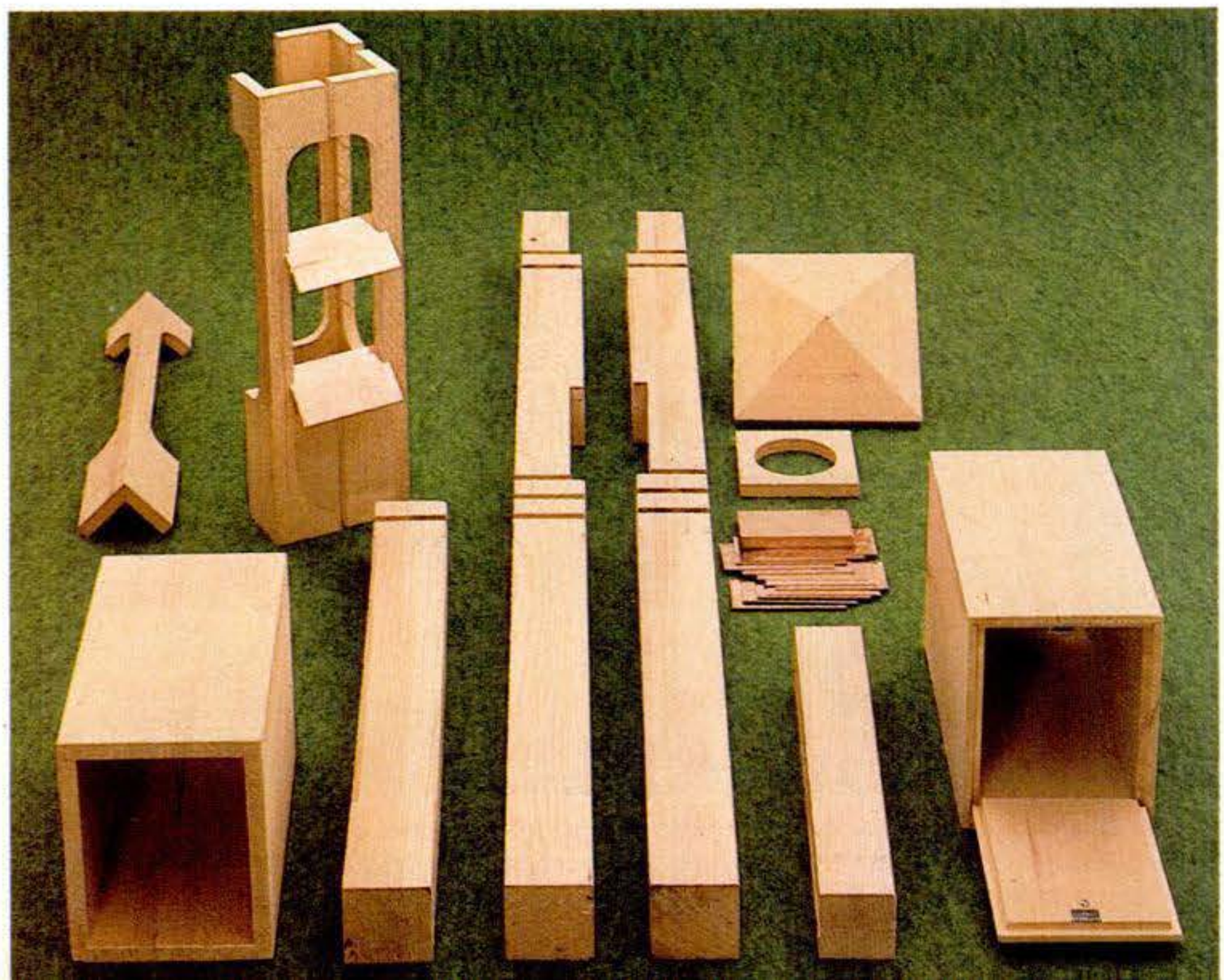
adds touch of class

By PAUL BOLON
JULIA LUNDY STURDEVANT AND RALPH CEREGHINO, DESIGNERS

Architects are often dissatisfied with ordinary fixtures around their homes—inside or out. Julia Sturdevant, a landscape architect in Portland, Ore., is no exception. She saw no reason to stick a traditional mailbox—a 4× 4 with a galvanized metal box on top—out in front of her contemporary home.

Her solution was an elegant design that combines a mailbox, an outdoor light, and a newspaper box in one project. The lamp and mail center was built of Douglas fir that was stained and sealed. Underground wiring for a low curb light was already in place, so it was only necessary to set a concrete footing and extend the wire and conduit up between the posts to the fixture (see drawing on facing page for construction details). Then the posts and wood parts were assembled around the conduit and secured to the footing.

Note that custom-built mailboxes require prior approval from your local postmaster before you can substitute them for existing types. Boxes are generally 3½–four feet above the roadway (not the top of the curb), but it's a good idea to check with your postmaster for an exact height and also what, if any, street or box numbers need to be inscribed on the side of the box. PS



The appearance is striking, yet lamp and mail center (top left) blends with surroundings because of all-wood construction. Major frame pieces are shown at left before assembly, except for decorative chamfers to be cut on posts. Wiring for light comes from house via underground conduit; switch is in house. Light bulb is changed by removing peaked cap. Photos by Western Wood Products Assn.

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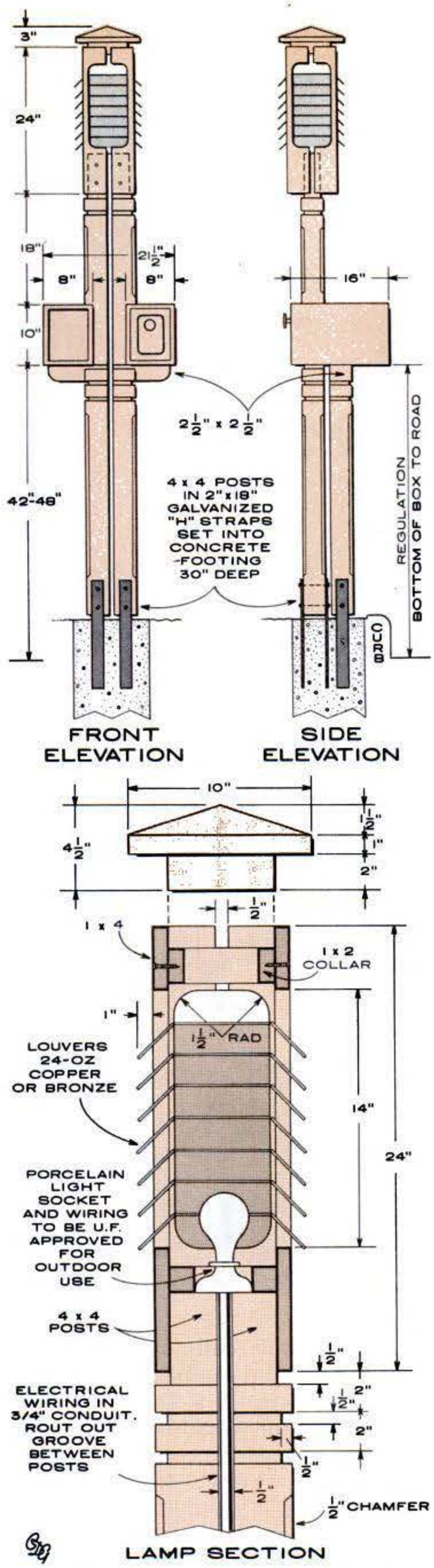


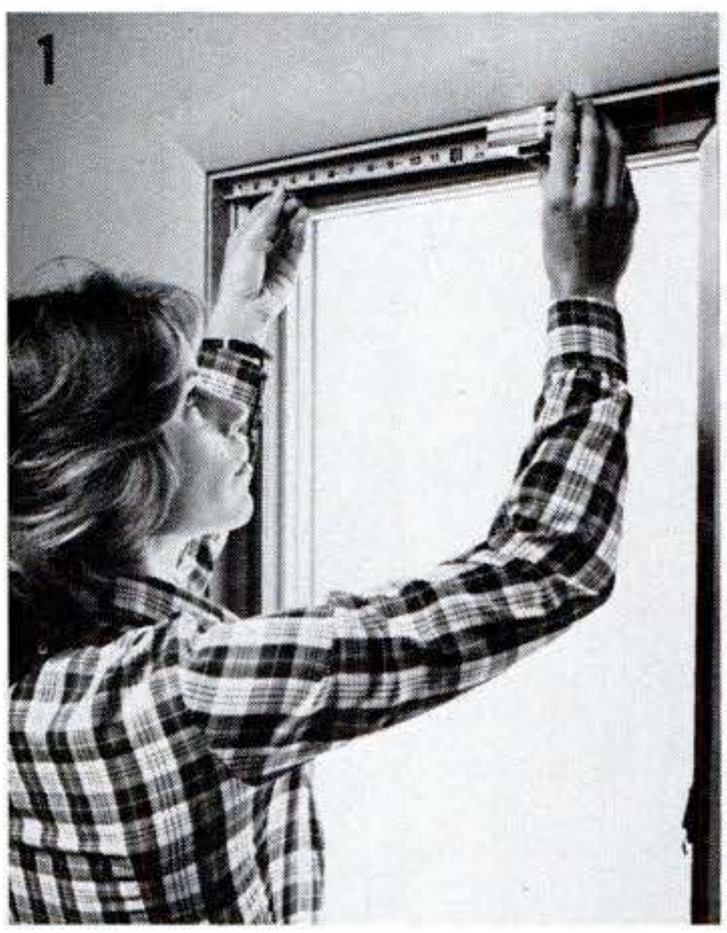
Backbone of lamp post is two full-length 4×4's secured by galvanized straps embedded in concrete footing. Dadoes for conduit are routed in post's mating faces; decorative chamfer is also routed. Boxes fit in notches in tall posts, and are also supported by crossmember atop third, short post. Light socket is special porcelain model for outdoor applications. Copper or bronze louvers are cemented in slots with small amount of exterior-type epoxy. Box sides and back are rabbeted together and screwed to posts and crossarm support. Check with local postmaster for height from road to box bottom.

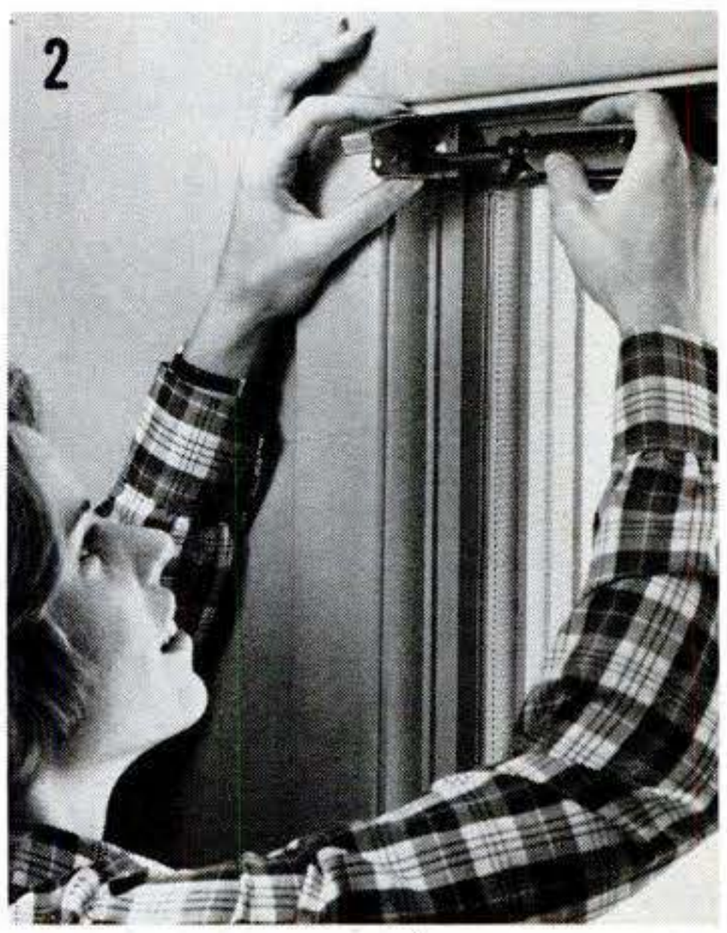
Install your own mini-blinds

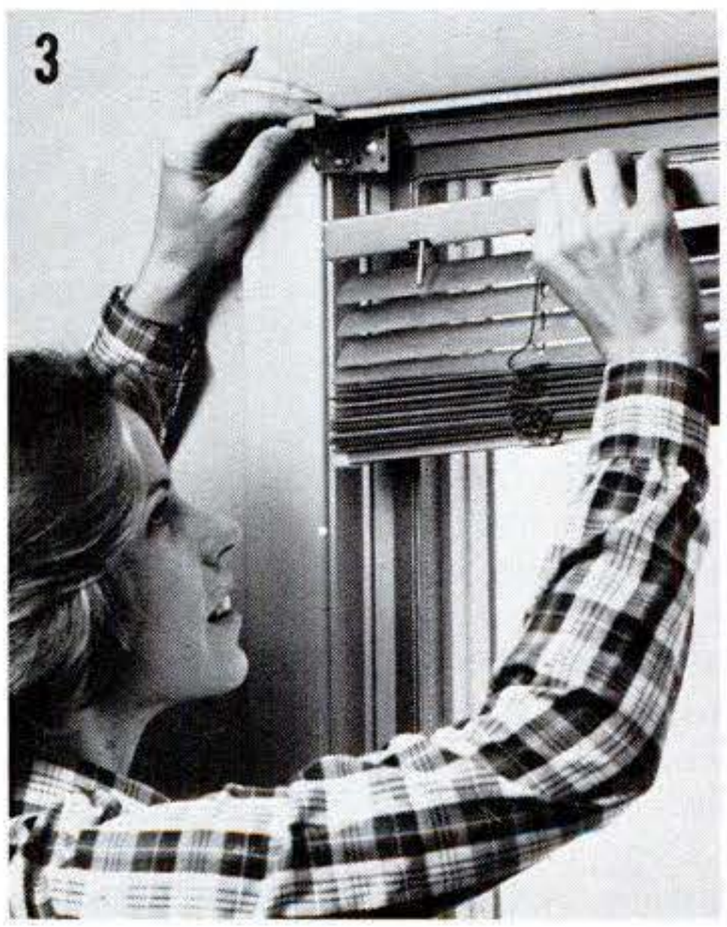
Venetian blinds have always been a practical idea. They let you have as much or as little sun as you want by adjusting the angle of their slats. But conventional-size slats may pose a problem: Open them a little, and you don't get enough sun; a little more, and you get more than you want.

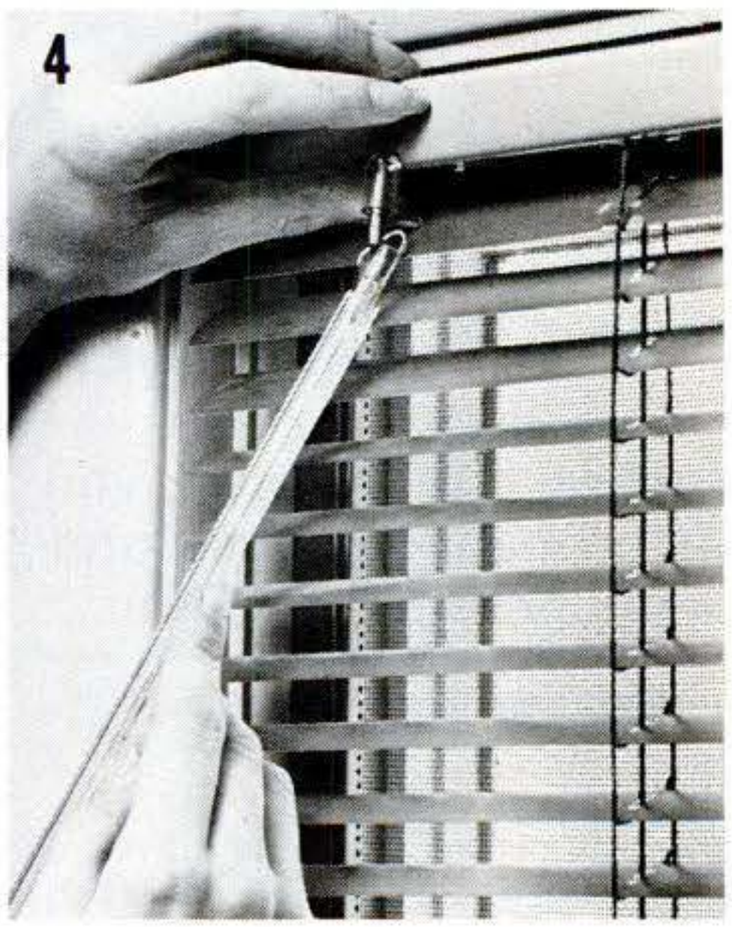
Mini-blinds from Kirsch Co. (Sturgis, Mich. 49091) might help solve that problem. Their slats are only one inch wide, and will fit any width window from 10 inches to 11 feet. Kirsch also claims they fit hard-to-reach corner and bay windows, and could be used as room dividers or pass-throughs, too.

Like conventional blinds, mini-blinds can be ordered with two-tone slats—room-colored inside, alabaster-colored on the window side. That exterior color reflects sunlight and helps keep the room cool in summer. The photos below show you how to install mini-blinds, without special tools or skills.—*Harriet Brown*









First step for installing mini-blinds: Measure your window. If you want the blinds to lap the window casing, measure the area you want them to cover. A good gauge is to add three inches to the width of the window itself.

If you want blinds to fit inside, measure window width at the top, center, and bottom (1). Use the narrowest measurement to determine actual blind width. For length, measure the inside of the window from top to bottom. If you want the blind to clear the sill, subtract ½ inch.

When you have selected a blind, position and fasten brackets in the upper inside corners of the window frame (2). (For wider blinds, use supports in the center of the window, as well.)

Open the blind so the slats stack vertically (3) and slide the blind into the brackets and supports. Slip the control wand into the eyelet of the hanger on the headrail of the blind (4). (Control wand replaces the string-and-pulley arrangement found on conventional Venetian blinds.)

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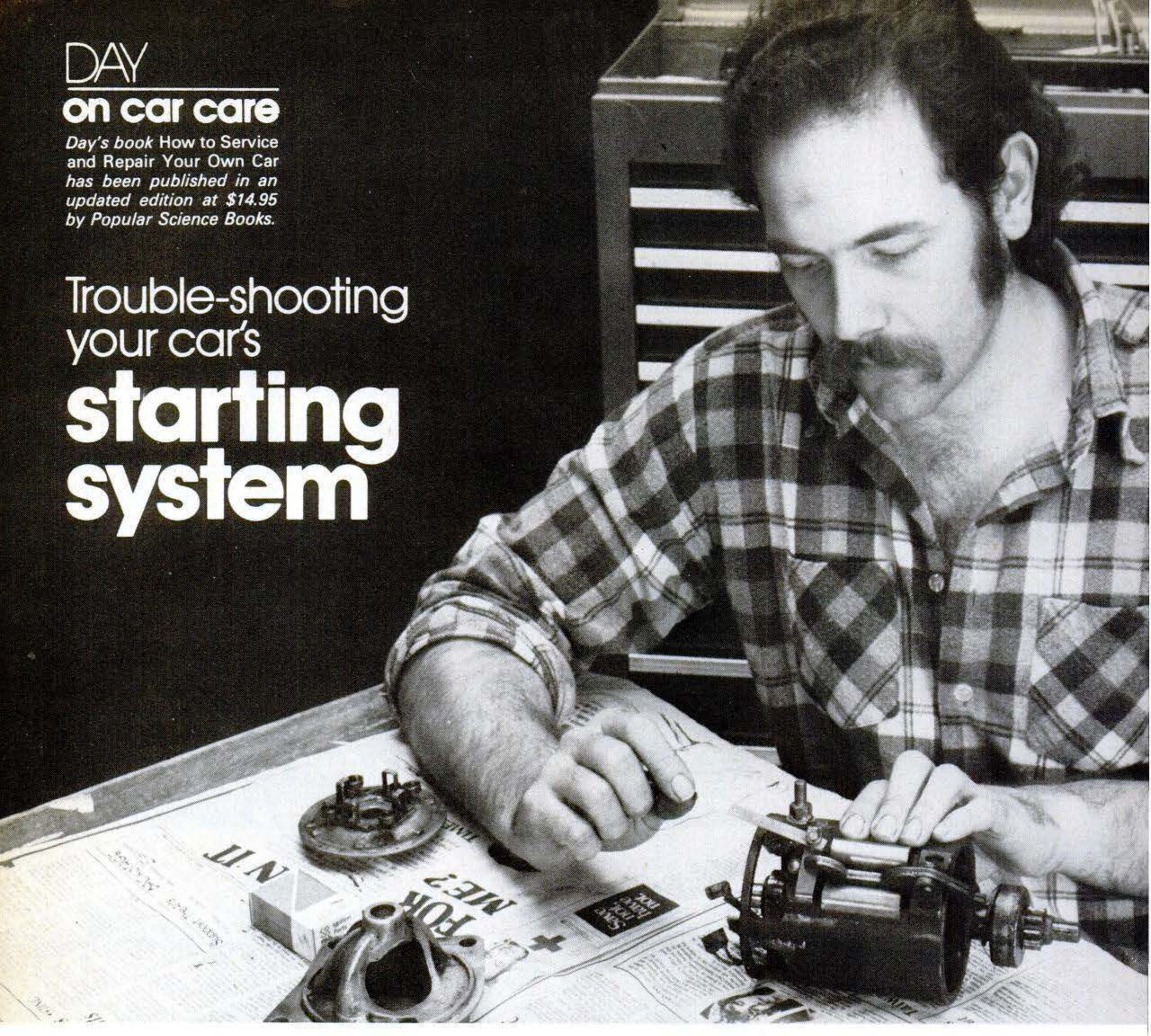
DAY
on car care

Day's book How to Service and Repair Your Own Car *has been published in an updated edition at $14.95 by Popular Science Books.*

Trouble-shooting your car's **starting system**



If your car won't start, you can probably pinpoint and fix the problem at home

By RICHARD DAY

Few automotive problems leave you flatter than a no-start. Sometimes the blame falls squarely on your car's starting system: battery, cables, wires, switches, starter motor, and starter drive. If you're certain the problem lies there—and is not an ignition or fuel problem—here's what to do:

Even if you've assembled an exceptionally well-equipped maintenance shop, you'll never be able to make all of the starting-system checks a professional garage can. But there are many you can tackle.

Begin at the battery; it causes most starting difficulties. The battery should have at least a 75 percent charge (1.230 specific gravity). If you can take hydrometer readings of individual cells, all should be within 50 points (0.050 sp gr), from highest to lowest.

Do you have a maintenance-free battery, without cell access? Run a load test with a battery-starter tester (BST). Or use the car's starting system along with a BST. The battery should show no less than 9.6 volts under load, after 15 seconds of loading at triple its specified ampere-hour rating. Tested with the starter running, the battery should crank the engine for 15 seconds without falling below 9.6 volts. A battery that passes both hydrometer and load tests is okay.

A maintenance-free battery with a state-of-charge indicator can be checked, without cell access, for charge and internal conditions. When no green appears on a Delco-Remy battery's indicator window (yellow on a Mopar), it's time for a charge. When a Delco's window is light colored or a Mopar's is black, it should not be tested, charged, or jump-started. Replace it.

If the battery checks out, clean its posts and cable terminals, and see that the terminals are tight on the posts for good current flow.

As you proceed through the following checks, make a careful visual inspection of the starting system, looking for loose connections, broken or dangling wires, and corroded terminals.

Headlight test. Turn on your headlights, which should be as bright as normal. Now try to start the engine.

Continued

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Comparison Chart

Features	PMC-80	TRS-80
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16,000 characters memory	Yes	Yes
Tape recorder for storing or retrieving programs	Yes	Yes
Use your own TV (Save $$)	Yes	No
Expandable to 48,000 characters of in computer memory	Yes	Yes
Use TRS-80 expansion interface	Yes	Yes
Expandable to 4 floppy disk drives (over 100,000 characters of storage on each one!)	Yes	Yes
Telephone Communications available: connect to large computers/electronic mail etc.	Yes	Yes
1000's of ready made programs availble for "educational" and "scientific" applications?	Yes	Yes
Printers available	Yes	Yes
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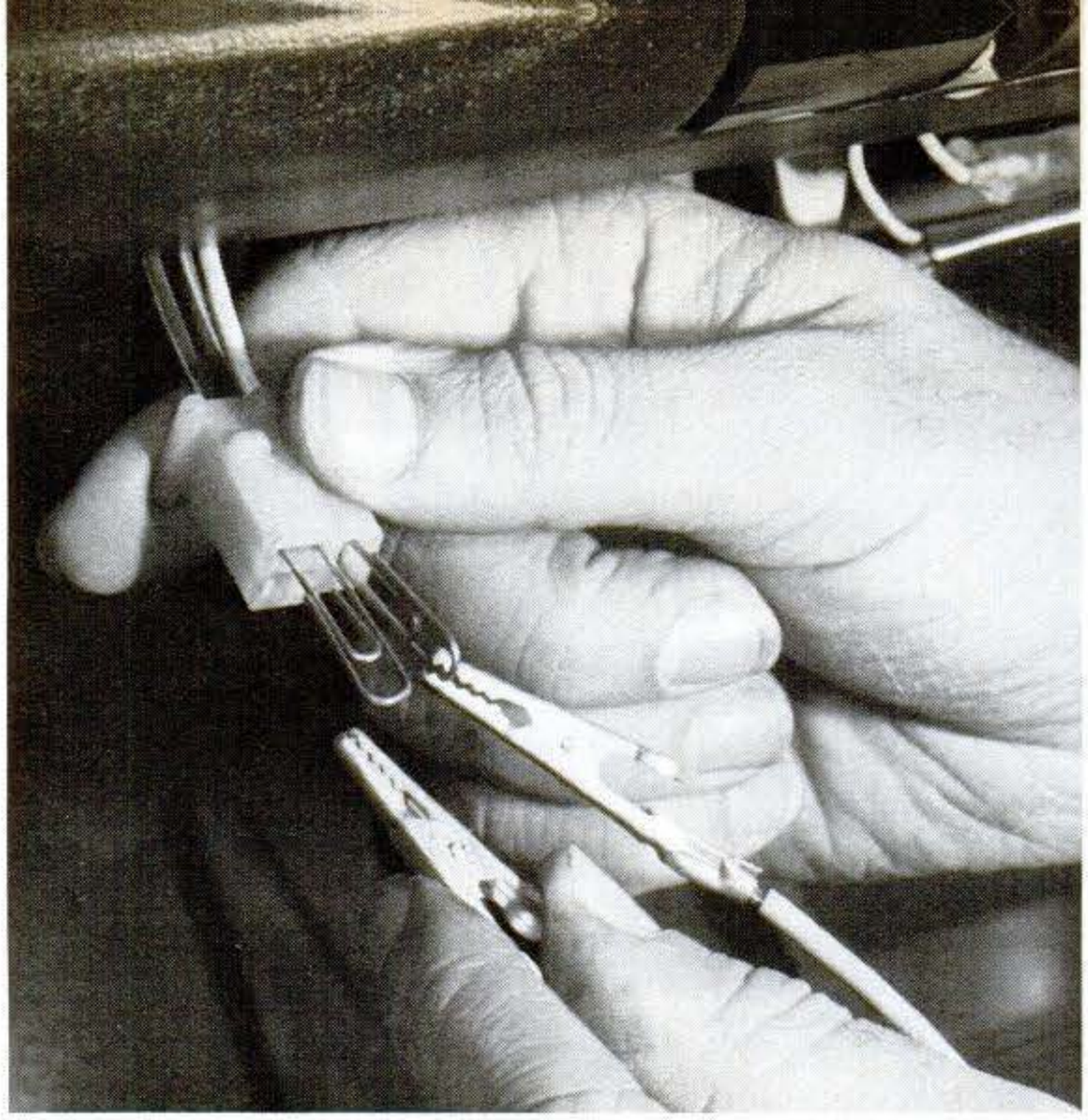

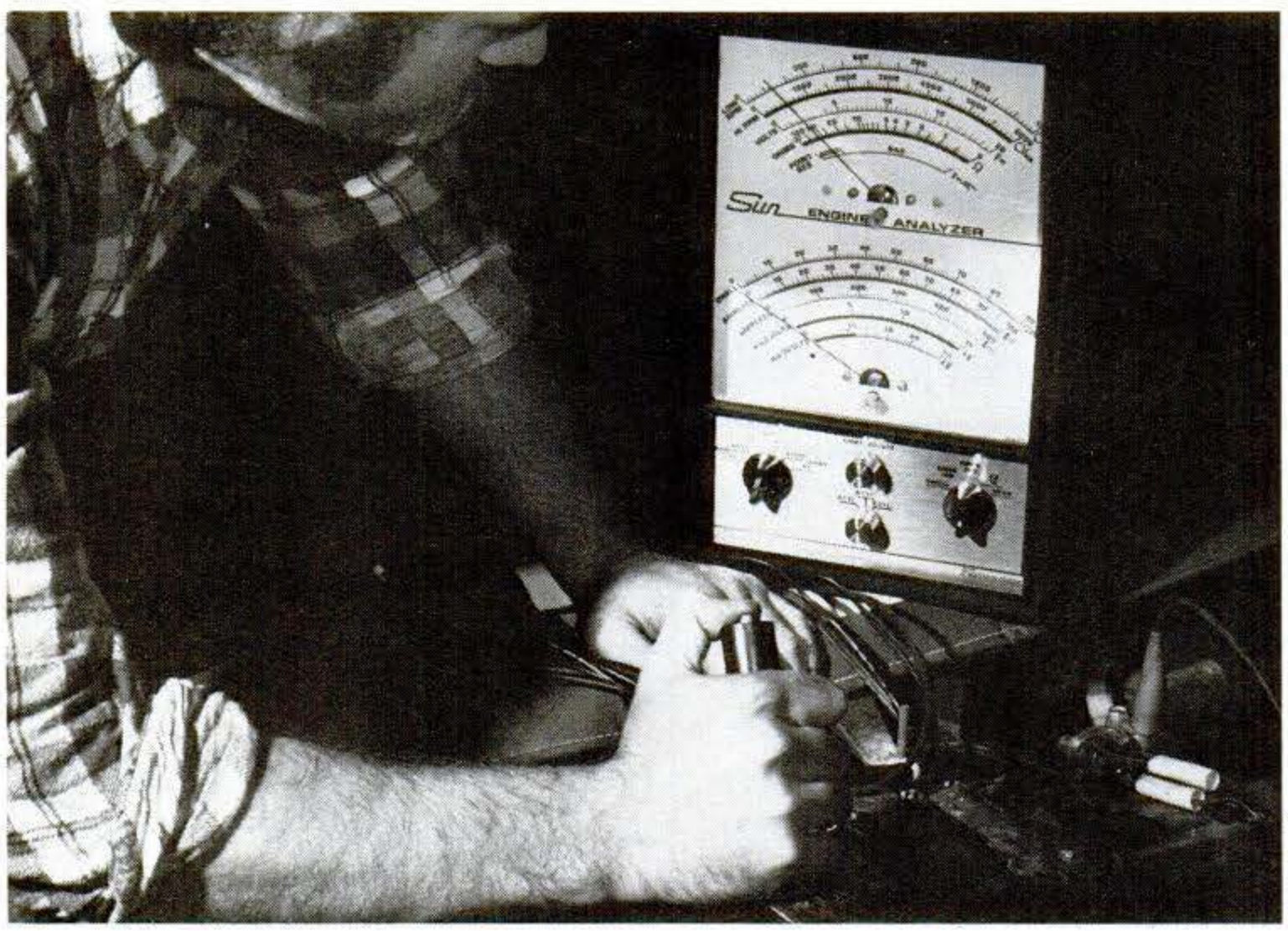

Starting system

[*Continued*]

The lights should dim only slightly as the starter begins to crank. If the battery is going bad, the lights will dim greatly and may even go out. If there's no dimming and no cranking, but you hear a click at the starter relay or solenoid, the primary circuit or the starter itself is suspect. The switching circuit is probably okay.

The primary circuit comprises the heavy cable(s) between the battery and starter, the relay or solenoid's main contacts, and the starter's ground. The secondary circuit is the light-duty switching circuit. It is actuated by the "start" position of the ignition switch, which closes heavy-current contacts within the relay or solenoid. This completes the primary circuit and gets the starter-motor current flowing. Starter relays are usually mounted on the fender apron, between the battery and starter. If your car uses a solenoid instead (as most do), it's mounted atop the starter. Solenoids also engage and disengage the starter pinion with the flywheel ring gear.

Primary-circuit bypass. If the battery is okay, yet the engine won't crank at 100 rpm or so, use a single jumper cable to bring power from the battery's "hot" terminal to the large starter or solenoid terminal. For safety, have the transmission in neutral or park, ignition switch off, and parking brake firmly set. If the engine now spins, there's something wrong in the insulated starter load circuit or switching circuit. If it doesn't, the problem is either in the starter motor or its ground circuit.

Switch bypass. If you got no clicking and no starter action on your initial try at normal starting (battery and connections okay), the likely fault is the switching circuit. To confirm this, bypass the circuit with a jumper wire (AWG 16 or 18 wire) from the battery's hot terminal to the switching connection, a small terminal on the relay or solenoid (use precautions listed above). The starter should work.

If it cranks, systematically bypass each component and section of wire from the battery to the starter. When

Continued

Bypass ignition switch by inserting paper clips into connector and bridging with jumper (top). Use extreme care in *any* bypassing. Check voltage drops while cranking engine with remote starter (center) or ignition switch. Check armature for shorts to ground with ohmmeter (bottom) or powered test light, from shaft to commutator bars. More than just a visual check for opens will require professional skill.

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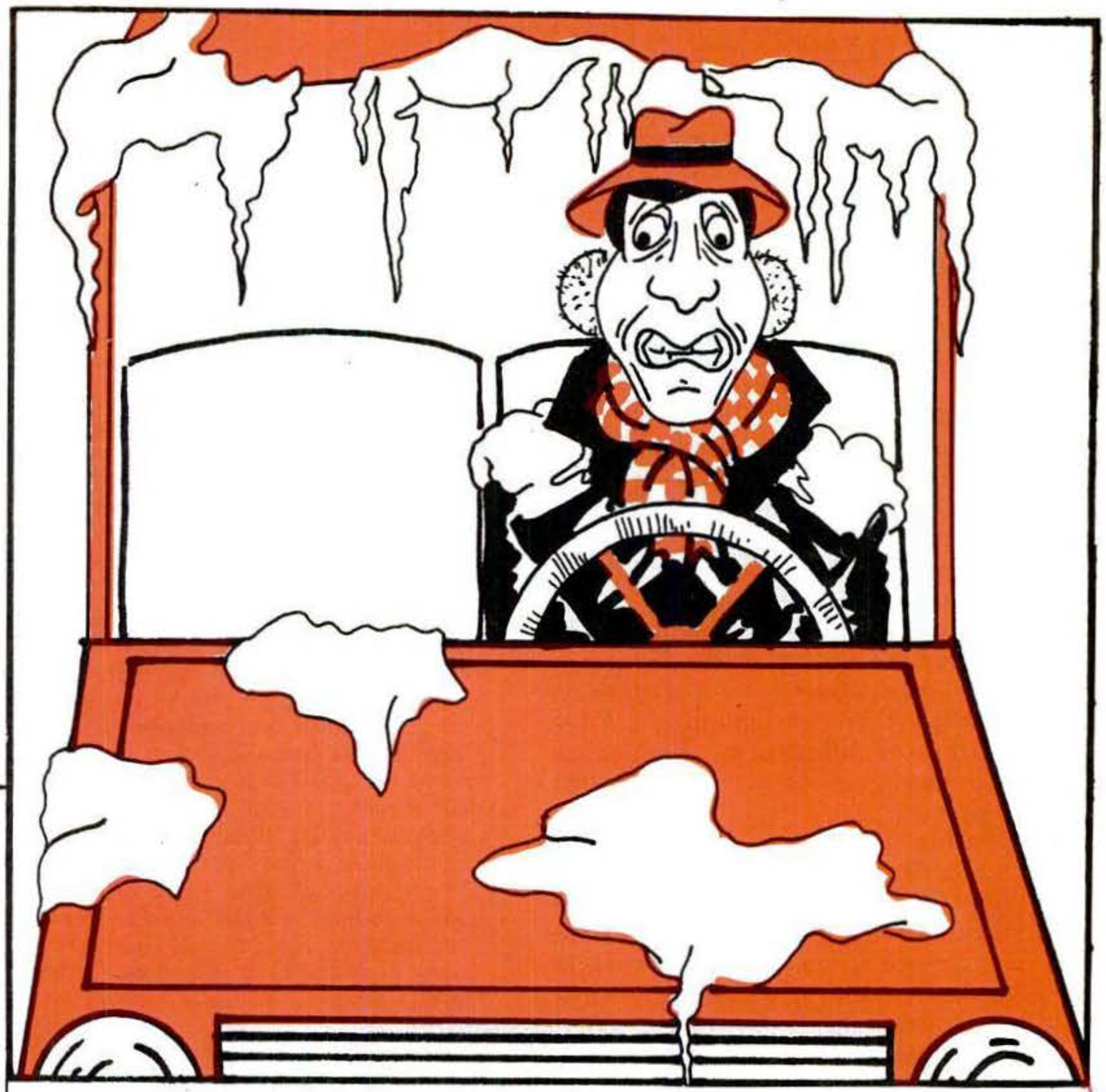

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you bypass the bad part or wiring, the engine should again crank. Of course, when not bypassing the ignition switch, you will have to turn it to the "start" position each time to actuate the circuit.

Open neutral-safety switch test. Often the problem is poor adjustment of the neutral-safety switch, found on all automatic-transmission and some manual-transmission vehicles. With your foot on the brake pedal, hold the ignition switch in the "start" position while moving the transmission selector around. If the engine kicks at any point other than "neutral" or "park," find the switch (it hides along the steering column or on the transmission) and readjust it by loosening its mounts, then retightening. After making the adjustment, check to be sure the engine starts only in neutral or park.

Voltage-drop tests. If the starter cranks the engine too slowly, it may not start. A major cause is excessive resistance in the insulated or ground primary circuits. Check for it while cranking, using a voltmeter with a zero-to-one-volt (or less) scale (see diagram). Auto makers' specifications call for maximum voltage drops of 0.3–0.7 volt on the loaded insulated circuit and 0.2–0.5 on the loaded ground circuit. If you get greater voltage drops, systematically check components and sections of the circuit, loaded as before. Maximum individual voltage drops should be: Short cables, 0.1 volt; long cables, 0.2 volt; relays, 0.1 volt; solenoids, 0.2 volt; connections, 0. A large drop means high resistance. Note: A starter that draws too much current because of internal shorts or starter or engine binding will give higher-than-normal drops.

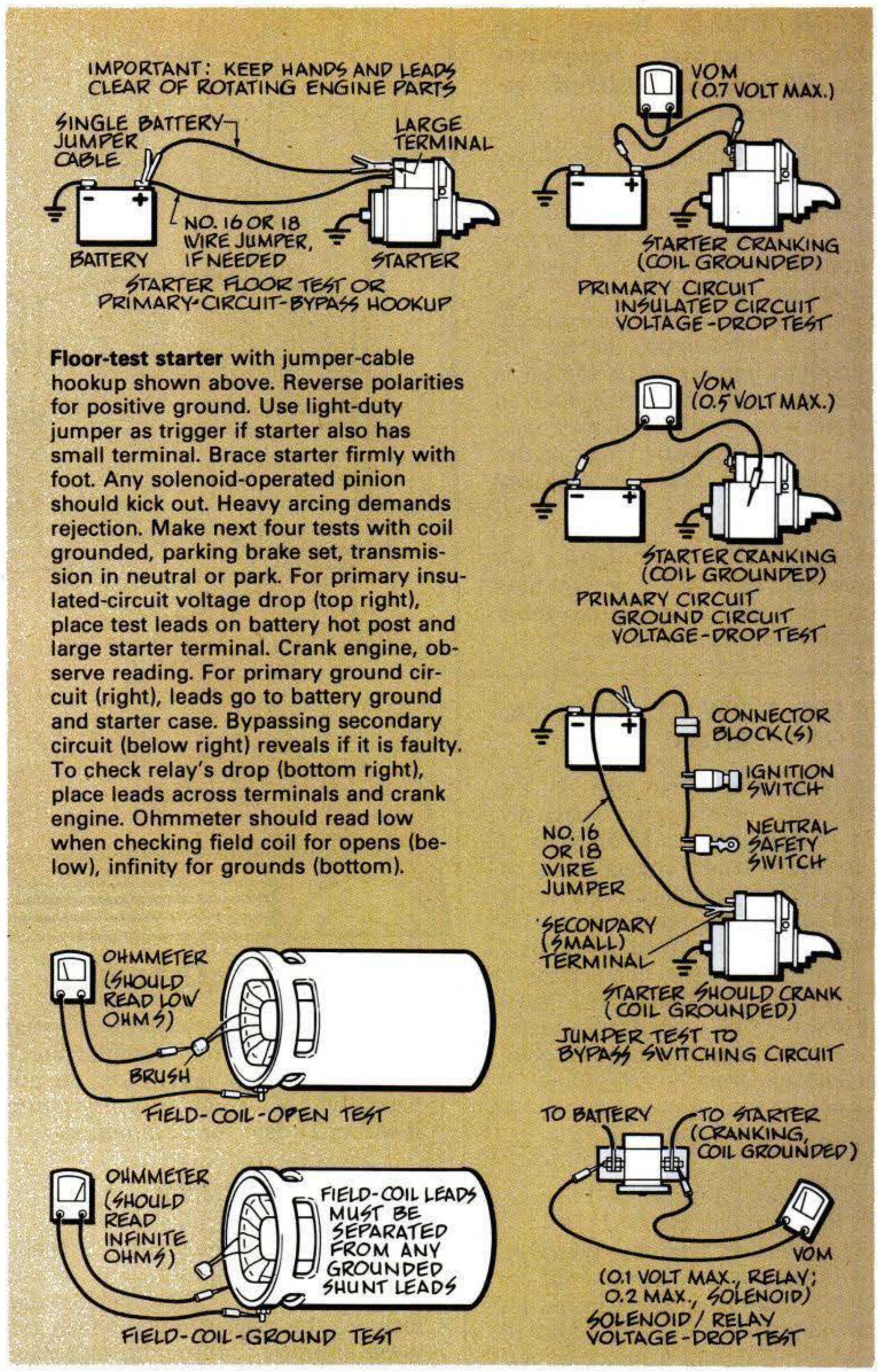
Starter motor. If you're hitless at the plate, you've about zeroed in on the starter itself. See where it's located and decide whether you or a pro will tackle its removal.

If you decide to go at it, first see that the car is safely blocked up before going underneath. Then remove the battery's ground terminal and mark the starter's leads so you can correctly reinstall them. Don't twist the primary cable when loosening the retaining nut. Next, undo the lower mounting bolt. Then cradle the starter in your free hand and remove the upper bolt. Watch it, though—starters are heavier than you'd think. Finally, snake the drive mechanism out past the flywheel ring gear.

While under the car, sneak a peek at the ring gear through the opening in the bell housing. The gear gets heavy wear where the engine comes to rest against cylinder compression. If teeth on either the starter pinion or ring gear are worn, milled, or missing, or if they fail to engage at least halfway, they should be replaced and any other problems corrected. The ring gear is often heat-shrunk onto the flywheel, so leave replacement to a shop.

With the starter out, you can now

[Continued on page 150]



Floor-test starter with jumper-cable hookup shown above. Reverse polarities for positive ground. Use light-duty jumper as trigger if starter also has small terminal. Brace starter firmly with foot. Any solenoid-operated pinion should kick out. Heavy arcing demands rejection. Make next four tests with coil grounded, parking brake set, transmission in neutral or park. For primary insulated-circuit voltage drop (top right), place test leads on battery hot post and large starter terminal. Crank engine, observe reading. For primary ground circuit (right), leads go to battery ground and starter case. Bypassing secondary circuit (below right) reveals if it is faulty. To check relay's drop (bottom right), place leads across terminals and crank engine. Ohmmeter should read low when checking field coil for opens (below), infinity for grounds (bottom).

Starting-system troubleshooting

Problem	Probable cause
No response when ignition key is turned	Dead battery; loose or broken cable connections; defective ignition switch, wiring, starter relay, or neutral safety switch; neutral switch out of adjustment
Clicking sound when trying to start; engine does not crank	Very low battery; poor battery-cable connections; defective starter relay or starter; locked starter or engine; open circuit in starting motor
Starter spins, but engine does not crank	Faulty starter drive; ring-gear teeth missing
Engine cranks, but too slowly	Battery weak; excessive starter-current draw; too much voltage drop in primary circuit; starter drive or ring gear misaligned or damaged; engine stiff; starter faulty; ignition timing overadvanced; liquid in cylinder
Engine cranks, but will not start	Start-current draw too high to leave power for ignition; cause other than starting system
Noisy starter operation	Loose mount; worn gears or bearings

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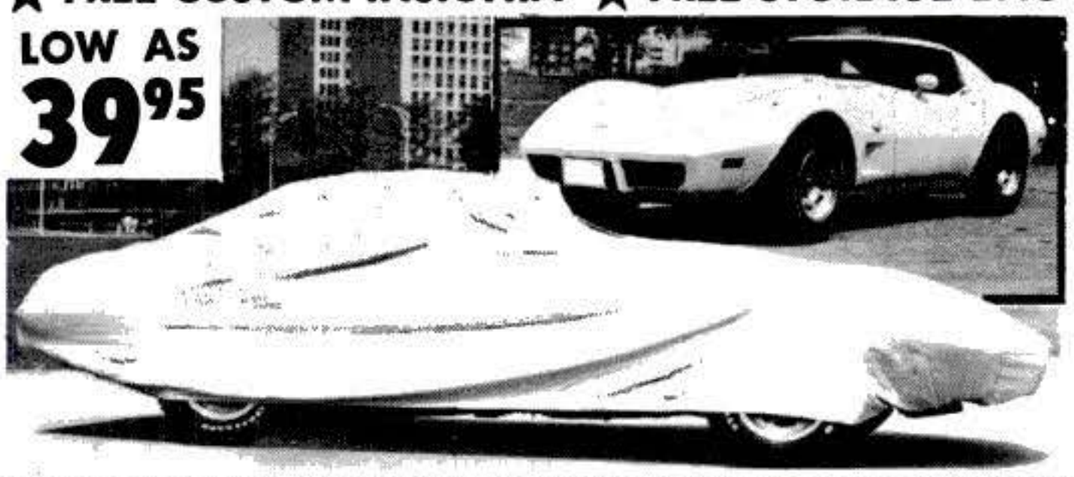

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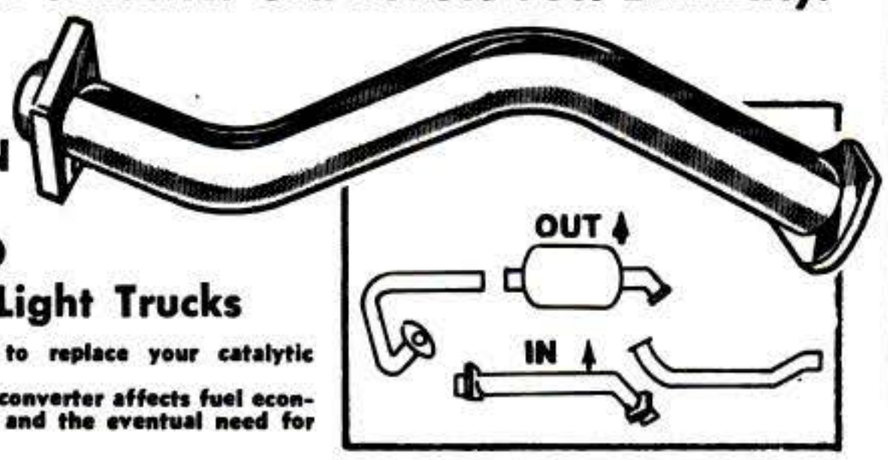

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- **Easily installed with ordinary tools . . . all necessary clamps and flanges included**

A malfunctioning catalytic converter creates excessive back pressure. It can decrease fuel economy, lower engine performance and cause premature wear. A clogged converter will eventually cause engine to stop running. Avoid these time-consuming, money-wasting problems: This converter tester lets you check the condition of your catalytic converter and determine if replacement is necessary. Heavy-duty, 16-gauge steel pipe is precisely engineered for a quick, easy fit. Includes factory-duplicate flanges and clamps where needed. **Note:** Federal, State and Local laws may prohibit the user from leaving this device on the vehicle after testing procedures are completed. **State Make, Year, Model, Engine Cu. In. If vehicle equipped with dual converters, 2 kits required.**

CONVERTER TEST PIPE FOR PASSENGER CARS

Make, Year, Model	Stk. No.	1-Kit
BUICK, LeSabre, Electra, Riviera and Century		
75-early 77 (32-1/2" long)	55-2718R	$23.50
77 late-80 (22-1/2" long)	55-2717A	19.95
75-79 Apollo, Skylark Skyhawk 6 and 8 cyl.	55-2718R	23.50
1980 Skylark	55-2719X	26.95
CADILLAC		
75-76 DeVille Calais	55-2718R	23.50
77-80 DeVille Calais	55-2717A	19.95
75-78 Eldorado	55-2718R	23.50
76-80 Seville	55-2718R	23.50
CHEVROLET Caprice, Impala, Belair, Monte Carlo, Chevelle, El Camino		
75-early 77 (32-1/2" long)	55-2718R	23.50
77 late-80 350, 400 eng. (22-1/2")	55-2717A	19.95
78-80 231, 350 eng.	55-2717A	19.95
75-79 Camaro, Z28, Corvette, Monza (6 & 8 cyl.), Nova	55-2718R	23.50
75-80 Monza, Chevette, Vega 4-cyl.	55-2718R	23.50
1980 Corvette	55-2718R	23.50
1980 Camaro, Z28	55-2717A	19.95
1980 Citation	55-2719X	26.95
CHRYSLER 75-79 New Yorker, Newport, Imperial, Cordoba	55-2718R	23.50
DATSUN 75-80 All	55-2719X	26.95
DODGE		
75-78 Monaco, Royal Monaco 400, 440 eng.	55-2718R	23.50
75-78 Volare Sports Custom 2 door	22-5298R	28.99
Volare, Aspen, Diplomat		
75-76 6 cyl.	22-5280X	29.99
75-78 8 cyl.; 77-78 6 cyl.	22-5281N	29.99
1979 6 cyl.	22-5283A	29.99
1979 8 cyl.	22-5284R	29.99
FORD		
75-78 LTD 302, single conv.	22-5297A	23.99
75-78 LTD, Custom 351, 400	55-2718R	23.50
1979 LTD w/dual conv.	55-2719X	26.95
77-79 LTD II, Thunderbird 302 w/dual conv. left side	55-2717A	19.95
right side	55-2718R	23.50
77-79 LTD II, Thunderbird 351 w/dual conv. right or left side	55-2718R	23.50
75-77 Thunderbird 460 eng. w/dual conv. left side	22-5287B	23.99
right side	22-5286U	23.99
75-78 Torino Elite	22-5300T	23.99
75-78 Torino w/dual conv. left side	22-5252W	23.50
right side	22-5253U	23.50
77-79 Mustang II V-6 eng. w/dual conv.	55-2717A	19.95
79-80 Mustang II 2.3, 3.4, 4.2 litre	55-2719X	26.95
75-79 Granada Ghia	22-5305B	29.99
1980 Thunderbird	55-2719X	26.95
1980 Fairmont w/200 eng.	55-2719X	26.95
w/255 eng.	22-5259A	29.95
LINCOLN		
75-76 Town Car 460 eng. w/dual conv. left side	22-5302R	$23.99
right side	22-5301A	23.99
77-79 Lincoln 460 eng. single conv.	22-5303X	23.99
77-79 Continental 400 eng. w/dual conv.	55-2718R	23.50
78-79 Versailles	22-5290W	23.99
MERCURY		
75-77 Marquis 460 eng. w/dual conv. left side	22-5293P	23.99
right side	22-5292B	23.99
75-77 Marquis 400 eng. w/dual conv. left side	22-5295N	23.99
right side	22-5294Y	23.99
1978 Marquis 351 eng. w/dual conv. left side	22-5282T	23.99
right side	22-5285W	10.99
79-80 Marquis 351 dual conv.	55-2719X	26.95
77-79 Cougar 302 eng. w/dual conv. right side	55-2718R	23.50
left side	55-2717A	19.95
77-79 Cougar 351 eng. w/dual conv. right or left	55-2718R	23.50
77-80 Bobcat V-6 eng.	55-2717A	19.95
OLDSMOBILE Delta 88, Royal, 98, Regency Cutlass, Cutlass Supreme		
75-early 77 (32-1/2" long)	55-2718R	23.50
77 late-79 350, 400 eng. (22-1/2" long)	55-2717A	19.95
77-79 231, 260, 305 eng.	55-2717A	19.95
1980 Delta 88, 98, Regency, Cutlass, Cutlass Supreme 307, 350 eng. (w/2-1/4" or 2-1/2" exhaust extension pipe)	55-2718R	23.50
75-79 Toronado, Omega and Starfire V-6	55-2718R	23.50
1980 Toronado 307-350 eng.	55-2717A	19.95
1980 Omega	55-2719X	26.95
PLYMOUTH 75-78 Fury, Grand Fury 400, 440 eng.	55-2718R	23.50
PONTIAC Catalina, Bonn., Grand Prix, Lemans		
75-early 77 (32-1/2" long)	55-2718R	23.50
77 late-79 350, 400 eng. (22-1/2" long)	55-2717A	19.95
77-79 231-301 eng.	55-2717A	19.95
1980 301 eng. w/2-1/4" or 2-1/2" exhaust extension pipe	55-2717A	19.95
75-77 Astre 4 cyl.	55-2718R	23.50
75-78 Firebird, Trans Am.	55-2718R	23.50
79-80 Firebird, Trans Am. (w/4-bolt flange on both ends)	55-2718R	23.50
1980 Firebird, Trans Am. 301 eng. (w/2-1/4" or 2-1/2" exh. extn. pipe)	55-2717A	19.95
75-79 Phoenix, Ventura (except 4-cyl.)	55-2718R	23.50
1980 Phoenix	55-2719X	26.95
TOYOTA 75-80 All	55-2719X	26.95
VOLKSWAGEN 75-80 Rabbit	22-5303X	23.99

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FORD		
75-79 trucks & vans w/6 cyl. or 302 w/2" pipe (exc. 1979 E-150)	22-5257N	8.50
75-79 trucks & vans w/351 w/2-1/2" pipe (exc. 1979 E-150)	22-5238N	10.79
1979 Econoline 150 302-351	22-5288P	28.99
1979 Econoline 100	22-5289Y	26.99
FORD (Cont'd.)		
78-80 Bronco	22-5271W	29.95
INTERNATIONAL SCOUT		
79-80 345 eng. only	22-5251Y	23.50
JEEP® VEHICLES		
75-78 All	22-5255R	14.95
1979 All	22-5238N	10.79
PLYMOUTH		
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1979 6 cyl.	22-5291U	29.99
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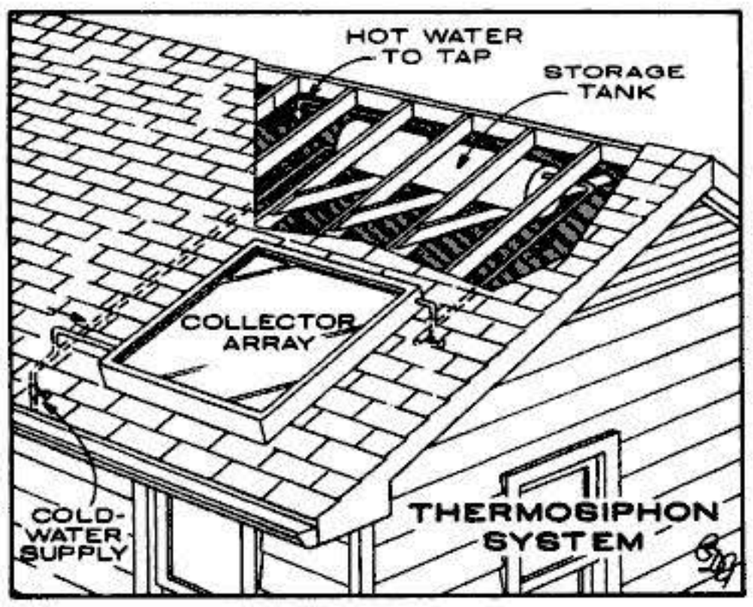
SHOP TALK

By PAUL BOLON

Solar hot water—the simpler the better

The first side-by-side comparison of six types of hot-water solar systems has been completed, and passive thermosiphon systems have proved to be the most efficient. The comparisons were made by the Solar Energy Research Institute (SERI) and based on data from six-month experiments monitored by the National Bureau of Standards. The other five systems tested were active systems, with liquids or air from collectors transported by a pump or fan. Two of these active systems were direct systems: single-tank and double-tank designs, with water as the collector fluid. The other three active systems were indirect; that is, their working fluid circulated in a closed loop, and heat from the fluid was transferred to hot water via heat exchangers. Two of these systems include single-tank and double-tank systems, with an antifreezing liquid as the collector fluid. The third system is a double-tank system with circulating air.

Thermal efficiency was measured by subtracting total collector losses (reflection and re-radiation) as well as piping and storage losses from the total energy of the available insolation (see table). Overall system efficiency was determined by subtracting other losses and cost of electricity for pumps, fans, or controls from the thermal efficiency.



The data generally confirm that second-tank systems result in loss of efficiency, as storage and piping heat losses exceed the lower collector losses of double systems. As you can see in the table, thermal efficiency of the single-tank direct liquid system was higher than that for the thermosiphon. But since a thermosiphon functions via natural convection currents between the collector and storage, without needing electricity for pumps or controls, its system efficiency was higher than that of the active system. And since the thermosiphon has the lowest system cost ($1328), it was the most cost-effective.

For most of us, though, passive thermosiphon systems remain beyond reach until they are made totally safe and reliable at the below-freezing temperatures most of us have in winter.

Another interesting conclusion reached in the study is that user habits greatly affected system efficiency. Consuming hot water in late afternoon and evening, rather than morning, boosted thermal efficiency by almost 10 percent.

Remember that these results were reached with six specific systems and should not be generalized to accurately gauge all systems of that type on the market. A copy of the performance report, "A Comparison of Six Generic Solar Domestic Hot Water Systems," SERI/RR-351-413, April 1980, is available for $7 from the National Technical Information Services (5285 Port Royal Road, Springfield, Va.).

COMPARISON OF SYSTEM PERFORMANCE	System losses (%)			Thermal efficiency (%)	System efficiency (%)
	Collector losses	Piping losses	Storage losses		
Thermosiphon					
Single tank direct, liquid	69.5	*	7.2	23.3	22.6
Active					
Single tank direct, liquid	55.4	1.7	14.7	28.2	21.4
Double tank direct, liquid	59.5	1.8	20.9	17.8	12.5
Single tank indirect, liquid	70.2	2.0	5.7	22.1	19.6
Double tank indirect, liquid	65.9	2.8	14.7	17.1	14.6
Double tank indirect, air	78.1	3.3	12.1	6.6	3.1

*Piping losses included with collector losses for thermosiphon

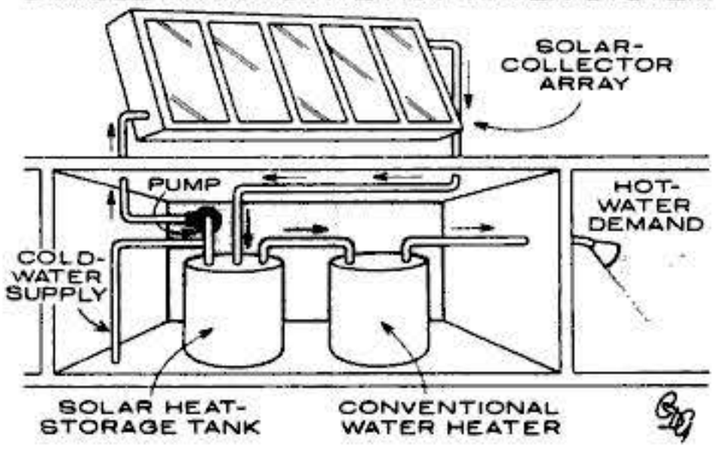
Solar assist

Anyone who has installed his own solar hot-water system knows that most people would spend more time designing the system than building it. There is quite a lot of information to gather, and more variables in the calculations—all interdependent—than most of us can juggle without getting a headache. It takes a computer to handle the job. That's where SolCost can help. It's a program that tailors a solar hot-water system to your needs.

The program was developed at Martin Marietta Aerospace several years ago for the Department of Energy. The Solar Energy Corp. has simplified the original and adapted it for homes and businesses.

The program provides two kinds of information: system design and cost analysis. It specifies the following design elements: correct collector tilt angle, optimum collector size for maximum payback over a 20-year life cycle, and storage tank size. The cost analysis determines your return on investment and provides a cash-flow table. By running your program and

DOUBLE-TANK ACTIVE HOT-WATER SYSTEM



varying some of the factors—making several runs—you can, for example, compare components of different manufacturers or even different types of collectors. Or you can search for the size of the most cost-effective storage tank, usually an expensive item. You can also compare the cost of buying and installing components yourself versus paying a contractor. With over 150 data entries, or variables, you can do quite a lot. But most of us can find out all we need to know by entering only 14 basic items of information. The computer program has default values for the other variables. The system designs components for an active, double-tank system (diagram above). A single run—which is probably all most people will need—costs $25, with succeeding runs $5 less per run up to a total of five. For a free brochure, write to: Solar Energy Corp., 553 Pretty Brook Rd., Princeton, N.J. 08540. The user manual and questionnaire cost $5; part is refunded when you run your program.

Surface-mount or mortise?

After my article on patio-door security appeared in the July issue, I heard from W&F Manufacturing, one of the leading makers of sliding-door hardware. W&F president Philip Ewing pointed out that in the company's tests, a quality surface-mount lock was as effective as a mortise type—especially when used with an equally strong keeper. And the surface-mount lock is a more likely replacement for a poor original equipment lock because the leading stile on most doors is not deep enough to take the mortise type. Locks for sliding doors made by W&F and Adams-Rite can resist a 1000-pound prying force. Standards recently adopted by some communities on new door hardware, by comparison, call for a minimum of only 300 pounds. W&F does not sell directly to consumers, but its locks are available from two distributors: Slide-Co (Box 51, Ontario, Calif.); Blaine Window and Hardware (1919 Blaine Dr., Hagerstown, Md.). PS

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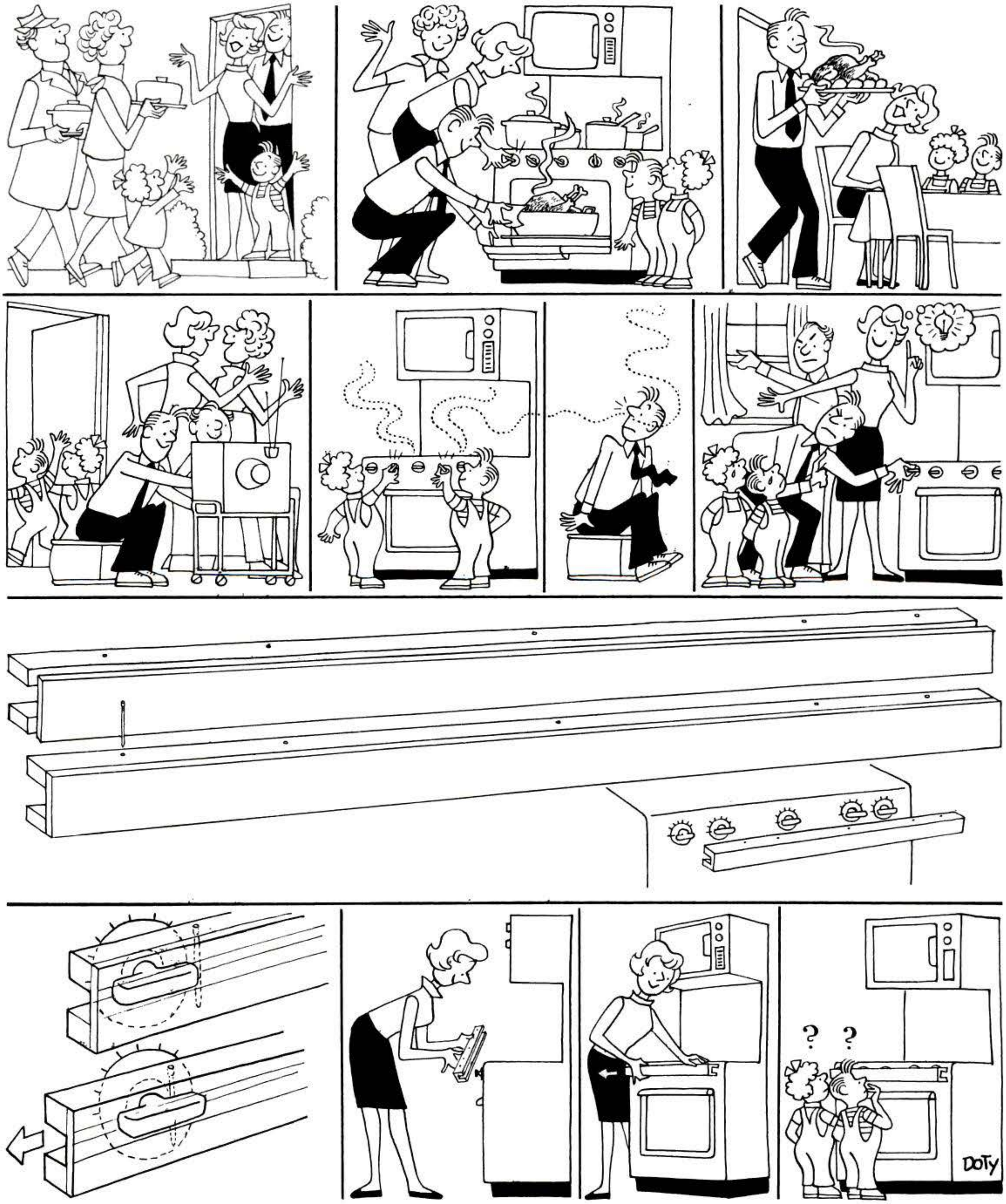
By ROY DOTY

$50 to Myron Eppley of Huntington Beach, Calif., for this idea. Send yours (with Social Security No.) to Wordless, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. Only purchased ideas will be acknowledged.



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If the unit fails because of factory defect within 90 days of purchase, it will be repaired at no charge for labor and parts - you just send the unit United Parcel prepaid to the Service Center designated and it will be sent back to you promptly United Parcel prepaid! A complete Diagnostic program tape and instructions are available. You can get a Service manual, Cassette alignment tage, Schematics, and parts list plus a Money Saver Service and Warranty Card. Everything you need to check and service your computer.

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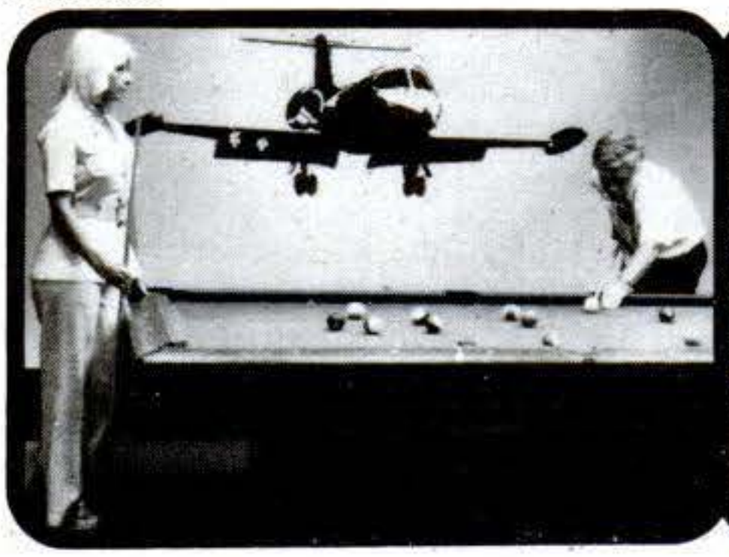

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PRICES GOOD THROUGH DECEMBER 31, 1980 SO ORDER NOW!

Costly wallcoverings

[Continued from page 122]

reactivate the adhesive. Then press the foil lightly back onto the wall.

Reed experts caution that foils are electrically conductive. Always pull the fuse when pasting foils around electric outlets or exposed wiring. It's also best to dry-cut for these openings before pasting.

Flocked wallcoverings can be as tricky as foils and should also be dry-hung over lining paper. Before hanging, apply a thin coat of adhesive directly to seam areas to improve staying power. Don't use seam rollers with flocks; instead, press seams together with fingertips. To preserve the nap, brush gently in one direction.

Felt, burlap, and other fabrics without a paper backing make handsome wallcoverings, but also require careful treatment. A shrinkage test is the key. Before buying enough fabric for the room, dry-hang a yard. If the fabric shrinks more than $^1/_{16}$ in. overnight, don't buy it.

Most fabrics (except for thin silks) don't need lining papers. But all should be dry-hung, one strip at a time. If seams don't lie flat, thicken the paste, and let it get tacky before you press the fabric on the wall.

Handle felt and burlap carefully—both may stretch if wash water gets on them. If you press felt down too roughly, paste may ooze through the seams. And smoothing burlap all the way to the edge may raise the fibers. It's best to set the edge with a seam roller, but don't press too hard—it'll make the fibers shiny.

To get even shading with felt, you simply dry-hang the strips normally, aligning the tops. But you may have to do the opposite with burlap. Check by hanging the second sheet next to the first without trimming. If the fabric shade brightens abruptly at the seam, reverse the second strip.

Like burlap, heavier grasscloths may tend to have fibers that lift away at seams. To avoid this, apply a little vinyl adhesive along the back of the edges before dry-hanging.

Cork, another handsome but tricky wallcovering, is often laminated to a thin, glossy paper that tends to curl. The only solution—fold carefully. Paste and fold one sheet, set aside, then do another. By then, the first sheet should be relaxed of curl. Open it, repaste lightly, then hang.

Finally, the Reed experts advise making cosmetic touch-ups—with cosmetics! Eye shadows are great for camouflaging spots on flocks or fabrics. And eyebrow pencil does a good job filling in those hairline cracks where walls show through seams. PS

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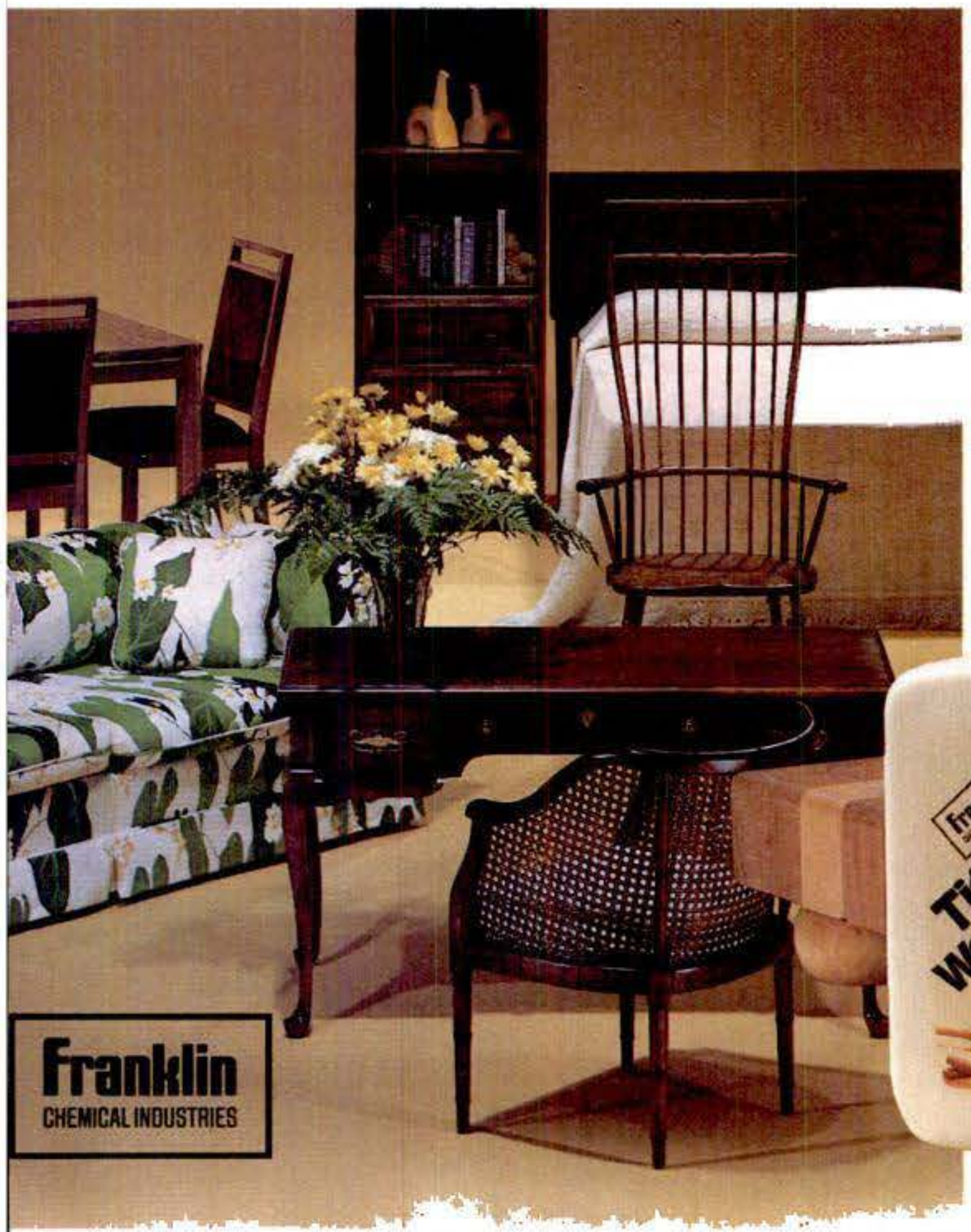
Franklin Titebond® Wood Glue is the first choice of America's leading furniture makers.



It's not surprising. Because Titebond® Wood Glue is the strongest woodworking glue there is. It spreads easily, sets fast, aligns easily, and won't gum up when sanded or sawed. It's unaffected by lacquers, varnish, or sealers. It can be painted. And it washes off hands and tools with warm water. The things that make Titebond® Wood Glue first with the biggest names in furniture make it first for any woodworking project you have in mind. Want proof?

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For order blanks and information, look for the Franklin Titebond® Wood Glue display at your favorite hardware or building materials dealer, home center, or hobby store.

TC-801

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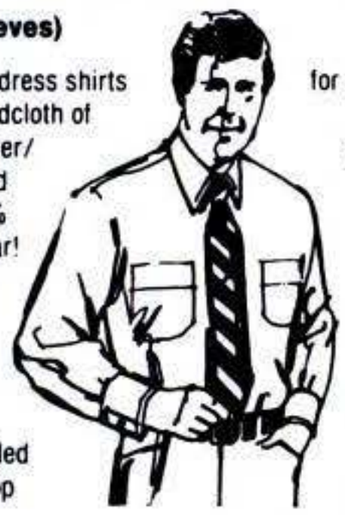
3 Great Shirts only $22.75

(short sleeves)



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Qty.	Color	Neck	Sleeve Lgth.

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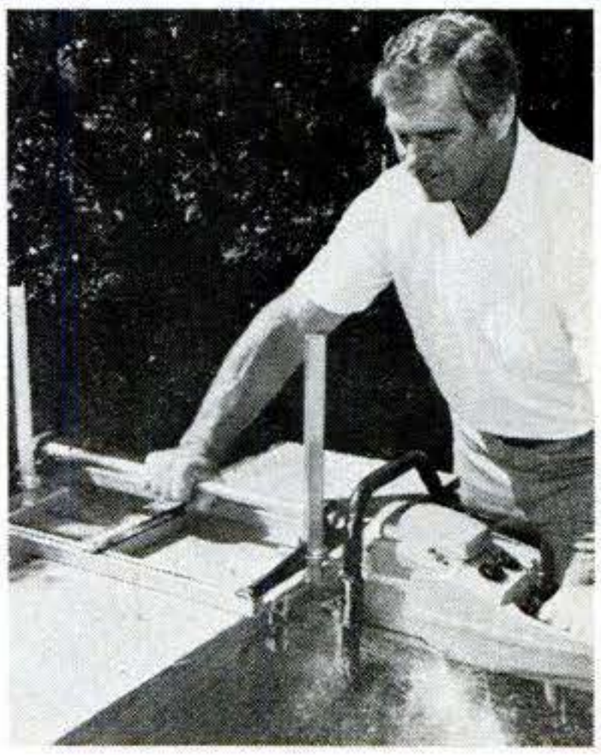

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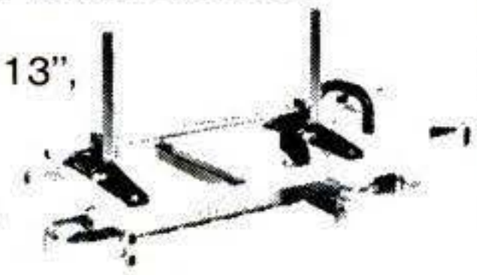

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A clinic on cars by Smokey Yunick, America's most famous mechanic

Convert to propane?

I have heard that RV's can be converted to burn propane gas. I'd like to know if the saving is substantial. What would be the advantages of this conversion?

S. Ponak, Montreal, Que.

Unless you can get propane very cheaply and drive enough miles to offset cost of the initial conversion, I doubt that you will save at the bottom line. It is a good fuel, though. There are some startup problems during cold weather, but they can be solved. It is not an across-the-board answer to our impending liquid-fuel shortage, however.

Wants to use gasohol

Being in the heart of gasohol country, I would like to use this fuel in my new Honda Accord-LX hatchback. Should I?

Kenneth D. Rose, Lincoln, Neb.

Gasohol fixes nothing, in my view. But in a pinch you can use it without trouble—unless the carburetion is already on the borderline of being lean. In this case it will lean it out further. With sustained use you may have to increase maintenance, except in engines that have materials compatible with alcohol designed into them. Watch the oil condition. Look for water or dilution until you learn how the oil is going to react.

Noise at startup

My 1980 Datsun 510 makes a lot of noise when it's started after sitting overnight. This lasts three to five seconds. Evidently, most of the oil drains from the bearings and other components.

My dealer says this is normal for all Datsuns, but he's never heard this car start after it has been parked overnight.

G. F. Merrick, Dayton, Ohio

I'd consider using an oil filter with a check valve to stop the drain-down. But this is not an area for guessing, it's an area of manufacturer responsibility. I suggest you go to a higher level of Datsun command. Let a factory rep hear it on a 12-hour start cycle. Heavier oil will help, but then it will get you on mileage.

Transmission jumps out of gear

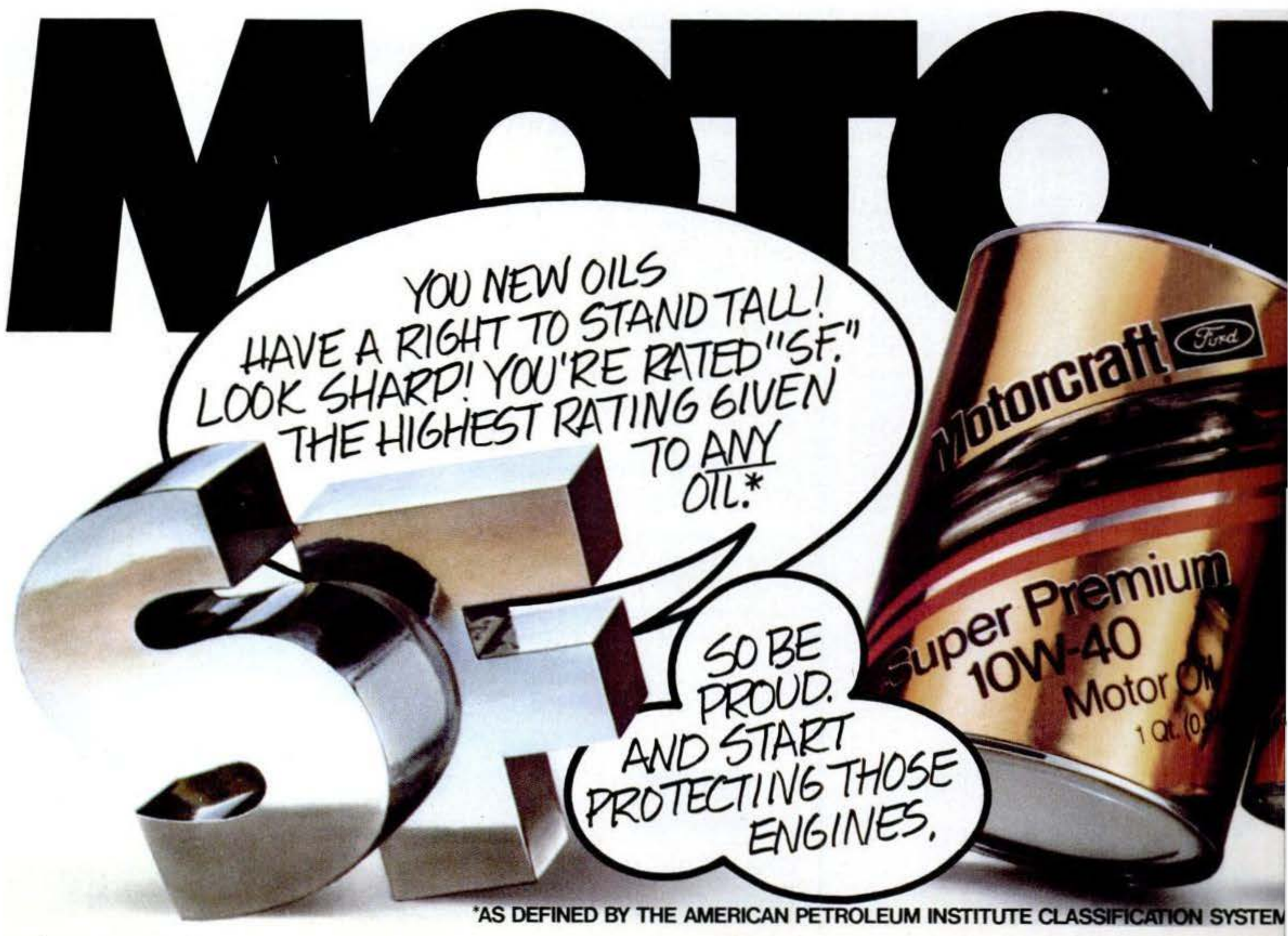
I purchased a 1980 Chevette with only 1200 miles on it. From day one, the four-speed manual transmission has jumped out of fourth gear occasionally. I have taken it to the dealership three times now, but it never jumps out of gear there.

The weather seems to be a factor. It will jump out of gear in 40-degree temperature or lower, but after the car is warmed up, it's okay.

The dealership and the GM field rep said the synchronizers needed to be broken in. I hope you can shed some light on this subject.

Jack Henderson
West Mifflin, Pa.

Determine if a shift to fourth lines up the detent; be sure that full engagement is occurring. I don't consider this normal or agree that synchromesh clutch wear is the solution. Check for interference between the shift lever and the body or floor mat, which might kick the transmission out of gear when the engine tries to rotate in its motor mounts during acceleration. If all



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the above are okay, check for a lack of correct engagement or an upper-shaft support problem (bearing). Excess end-play in the rear shaft could also be the cause.

Wonders if he should sell

I bought a 1972 Peugeot 504 with 75,000 miles on it in 1977. It now has gone 102,000 miles. It had not been maintained well. I put in a new transmission, rear end, exhaust system, coil, battery, and wiper motor.

Now the manual choke is giving me problems. Peugeot claims I must buy the whole upper half of the carburetor for $250 to fix it. The car lacks pickup and runs badly from a cold start. At highway speeds, after warm-up, it's great.

It's a fun car to drive and the body is okay, but nobody will give me any more than $600 for it as it stands. Does it make sense to replace the engine and radiator with a good, reliable, easy-to-fix U.S. motor (with air conditioning)? Which engine would you recommend? Or am I better off selling it and cutting my losses?

Jack Gardner, Middlesex, N.J.

Sell it. Your plan to repower would be a loser.

Using too much oil

I have a 1978 Rabbit with fuel injection. It has gone 46,000 miles. I burn regular leaded gas. My problem is that it has never stopped using oil. The spark plugs never show signs of burning oil, so the oil must be going by the valve seals. I get excellent gas mileage, 33-36 mpg, with advanced timing and a high vacuum reading.

Not too long ago, VW sent its '77 and '78 Rabbit owners a letter to "check the oil every fill-up." My VW dealer says "one quart of oil every 500 miles is average." I feel like I have a diesel.

I've read you also have a Rabbit; have you had oil trouble? I'm a competent mechanic and want to put new valve seals in myself. I hesitate to buy the original when I can get a copy. Do you know of any other seals that would work better? I've had five VW Bugs, and this is the first VW product that ever used oil. I now use one quart every 400 miles.

Bill Landske, Cedar Lake, Ind.

Here's what I recommend: Use Perfect Circle valve-guide seals, Seal Power rings, and make sure there is plenty of oil-drain area in the oil ring-land of each piston. Finish-hone each cylinder with a head plate bolted on the block at the maker's specified cylinder-head torque, and be sure the top ring's end-gap is at minimum spec. Do all this, and 2000-3000 miles a quart is easy.

Wants to convert to unleaded

I have a 1969 Ambassador with a 232-cu.-in. six that will soon be getting a valve job. What kind of valve and seat changes can be made so I can burn unleaded gasoline or gasohol? Or must other parts of the engine also be changed?

John Stevenson, Sherwood, Ark.

The intake can get by as it is. The exhaust valve needs a hard seat. And the valve itself must be replaced with a hard one. Keep compression under 8.5:1. Everything else should be all right.

Runs fast when hot

I have a 1979 Pontiac Catalina. If the warm engine is on slow idle and is left standing for 15 or 20 minutes, rpm increases considerably. To hold the car back, I need to use brakes, especially in traffic. My dealer says there is no fix. I have a 301-cu.-in. V8 engine. Does it have a high-cam adjustment?

Sid Wolff, Red Falls, Minn.

When you get hot, you're sucking in air. Look for an air leak in an emissions control, a split hose, a bad carb gasket, or a cracked intake manifold.

Each month in POPULAR SCIENCE Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say Smokey—", Popular Science, 380 Madison Ave., New York, N.Y. 10017. Questions cannot be answered by mail.

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In cooperation with the American Plywood Assn., POPULAR SCIENCE is again seeking fresh, well-designed projects for home and yard—projects that take full advantage of the practicality and economy of plywood. (Plans sheets for eight of 1980's winners, as shown in the August issue, are available from APA at $1 apiece—address in coupon below.) As with last year, we'll pick three projects each in three categories, determined by the amount of plywood used. Get started now and your entry might double as a Yule gift.

Announcing the fifth annual PS/APA

PLYWOOD PROJECT CONTEST

$3750 in cash awards including three $1000 First Prizes! You have nine chances to win

● **PRIZES:** A $1000 check will go to the top entrant in each of three major categories. There will be a secondary award of $250 in each category for a total of $750 additional. An Honorable Mention entry in each category will receive a selection of how-to books from POPULAR SCIENCE Book Division.

● **HOW TO QUALIFY:** Your project must be constructed from a stated amount of APA-grade-trademarked plywood appropriate for the intended use: from ¼" to ¾" (thicker if required for structural strength); exterior type for outdoor or bathroom projects, interior for indoor ones. Projects should be carefully designed for efficient layout of the plywood sheet or sheets you select; parts should be scaled, arranged, and nested to minimize waste. You may enter your project in any of our three categories, specifying which thickness you choose for your half (4 by 4 ft.) or full (4 by 8 ft.) sheets. Should you choose to enter the multiple-sheet category, you have the option of using two or more different thicknesses, if structurally justified.

In all categories, aim for minimum waste and minimum use of additional materials; non-plywood purchases must not exceed $100, and plywood should remain the dominant material. We're seeking functional, structurally sound design, but decorative or ingenious projects will also qualify if they represent an efficient use of the sheet or sheets you specify, and if they can be built with home-workshop tools.

● **HOW TO ENTER:** Fill out our entry coupon, or list all information the coupon calls for on a separate sheet of paper—including a rough sketch of the APA grade trademark(s) stamped on the back face or edge of the plywood you chose. Mail this with at least one clear photograph (black-and-white or color print preferred, though color transparency is acceptable), plus a dimensioned diagram of how the project parts were laid out on the sheet or sheets. A crude pencil sketch will suffice if it's thoroughly and accurately labeled with critical dimensions. Please don't submit scale models, full-size cutting patterns, or plans sheets larger than 18x24 in. We also need a list of all materials used, grade and thickness of plywood, plus any lumber, hardware, and finishing materials (paint, stain, plastic laminate). Also jot down for us special construction tips you'd like to pass on to anyone attempting to duplicate your project. If no publishable photo exists, POPULAR SCIENCE and APA reserve the right to arrange photography at your convenience (and our expense). Entries must be delivered to the Tacoma Post Office Box by March 2, 1981; upon delivery, publication rights belong exclusively to APA and POPULAR SCIENCE unless neither exercises this option within six months.

Print the category you're entering (½ SHEET, SINGLE SHEET, 1½ TO SIX) in the lower left corner of your envelope (one entry per envelope, please). No entries can be acknowledged, and none will be returned unless accompanied by a written request and a self-addressed envelope with sufficient postage (no checks or money orders).

● **JUDGING** (by PS Reader Activities Editor Al Lees and representatives of APA) will be for the most efficient and appropriate use of the sheet or sheets you chose. PS will publish dimensioned plans of those prize-winning projects we feel our readers might want to make. Plans for all nine winning projects will be available from APA after Sept. 1, 1981. Prize winners will be notified by April 15. Winning entries will be shown in the August 1981 POPULAR SCIENCE. PS

ENTRY COUPON (Clip and attach to your plans sketch)

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Description of project _____

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What thickness(es) plywood? ☐ ¼" ☐ ⅜" ☐ ½" ☐ ⅝" ☐ ¾"

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My signature certifies that this project is of my own design.

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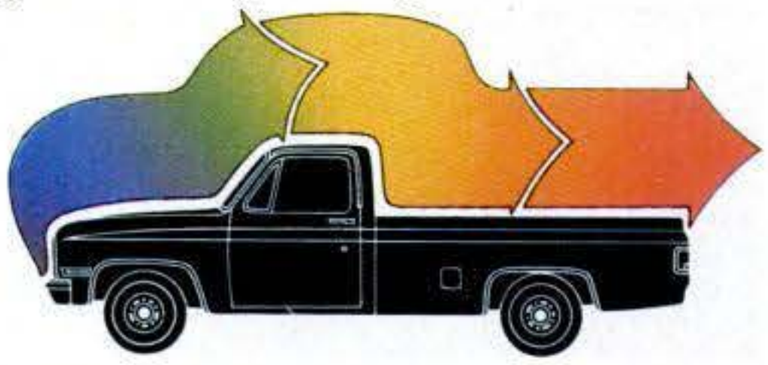

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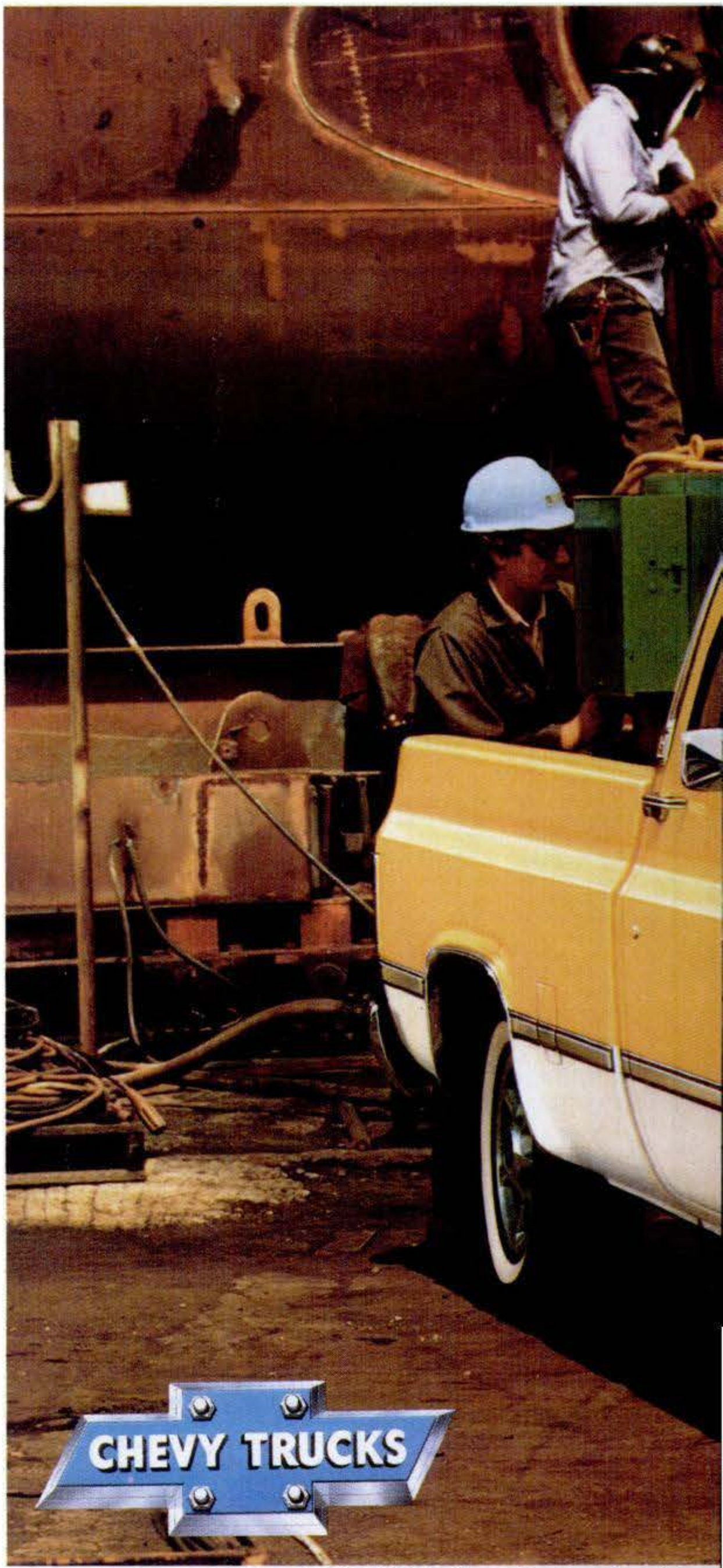

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CALCU-LETTER

By DARRELL HUFF News of pocket calculators—and how to have fun with them

How much do you owe?

If you're making regular payments on a car, house, or other loan, your calculator can tell you how much you'll still owe after any number of installments.

Suppose yours is a three-year car loan at 12 percent, with monthly payments of $149.47. After 29 months you want to save some interest by paying off the balance. How much is it?

To find out, express the interest rate as a decimal and find the periodic (monthly) rate by dividing by the number of months in a year. Add 1. Raise this result to the power of the number of payments remaining, then find the reciprocal (divide by 1). Subtract this result from 1, divide by the periodic interest rate, and multiply by the amount of the regular payment. You'll find you still owe $1005.66—$40.63 less than you would if you finished out your monthly payments.

I adapted this procedure from a book that should interest anyone who combines use of a pocket calculator with property dealings. It's Lawrence R. Rosen's *Calculator Mathematics for the Real Estate Professional,* published by Dow Jones-Irwin, Homewood, Ill. 60430 ($14.95).

Tricky triangle

Draw a line from the center of a circle to its edge, and another twice as long at 45 degrees to the first. Connect the ends of the lines. What is the area of the triangle thus formed if the area of the circle is 45 sq. in.? That was the problem posed in the September issue by a reader who called it his "little killer."

The solution proposed by the author of the problem used six pages worth of algebra and geometry and called for half a dozen formulas and construction of additional triangles.

But the answer comes along more quickly if you use the formula for the area of a triangle given two sides and included angle. However, I had to walk my fingers through a fair-sized math library before I found it: The area of any triangle is equal to half the product of two sides and the sine of the angle between them. You need only multiply sin 45 by the value of the radius squared, obtained from the standard πr^2 formula for the area of a circle. The solution: 10.128559 sq. in.

Indecipherable?

It seems that researchers at places like Stanford, MIT, and the Univ. of Wisconsin have developed a method for producing virtually unbreakable ciphers. It's based on the fact that no efficient system is known for finding the prime factors of a number. There is only trial and error. Prime factors, you'll recall, are divisors of a number that cannot be further divided by any whole number other than themselves and 1.

One new cipher system would use a 120-digit number that is the product of two secret primes. To break the code you'd have to discover these factors. It's a task for which a computer can be programmed, but it would take about 15 minutes less than forever for even the world's fastest computer to complete the required run.

With this background, James A. Raymond of Fairbanks, Alaska, thinks we might enjoy trying to discover the prime factors of a mere six-digit number. He suggests 663,133.

As I just noted, there is no way to solve this problem except by trying all the prime numbers less than the composite until you hit on the right ones. At first this might seem not worth your time, since there are approximately 50,000 such primes. (The prime-number theorem, proved in 1896 by Jacques Hadamard, states that the density of primes among the first n integers [as n approaches infinity] is approximately equal to the reciprocal of the natural logarithm of n.) Once you try the first few primes and find they don't work, though, you'll see you've already drastically cut the number of possible candidates. And when you think about it some more (and, in particular, discover why knowing the square root of the number is helpful to the solution), you'll realize there are only 140 or so primes that you have to consider.

Even now, you may still have a problem: Unless you can find a list of primes up to 1000, you'll need to generate these numbers yourself. A programmable calculator will come in handy here, but you can do it with any model with a memory function. You'll still have a great advantage over the Greek mathematician who devised the method of identifying primes referred to as Eratosthenes' sieve.

Start by listing every integer from 2 to as high as you wish to go. Then cross out every second number after 2. Then cross out every third one after 3, every fifth after 5 (4 was already eliminated), every seventh after 7, and so on. When the sifting is completed you will be left with the succession of primes.

Now you can begin trying to find which of these are the two prime factors of 663,133. Again, a programmable calculator makes it easy. After entering a mere 13-step program into an HP-19C, I found I needed only to touch a key and wait. The calculator found the factors and sat there awaiting a new challenge.

Lone who?

It's almost worth the price to own a calculator that dares to call itself the Loan Arranger. Like other specialized calculators, this one won't do anything a good financial or scientific model can't—but it's small, lightweight, moderately priced, and can be used without difficult formulas. Just feed in loan size, rate, and time, and it will instantly compute your payments. It does regular chores, including percentage calculations, too, and it has a battery-saving cutoff that operates if you ignore the machine for half a minute. There are drawbacks to such a specialized calculator, however: I could find no way to perform the payoff routine described above, and the very limited instruction book is no help. Loan Arranger II is available from Calculated Industries, Inc. (2010 N. Tustin, Suite B, Orange, Calif. 92665) for $29.95, plus $1 handling. It has an eight-digit LED display.

All-purpose display

These LED displays that you can see in dim or no light are all right for "office engineers," writes George L. DeWoyno, Huntsville, Ala., agreeing with another recent correspondent, and LCD's are the thing for "field engineers working in bright light." But there's a third choice, he says, suitable for both conditions: a fluorescent display like the one on his three-year-old Casio. Sometimes cal ed Digitron, these displays are a pleasant blue. Though the industry is going strongly in the direction of LCD's, you might still find pocket calculators with Digitron displays in your dealer's stock. PS

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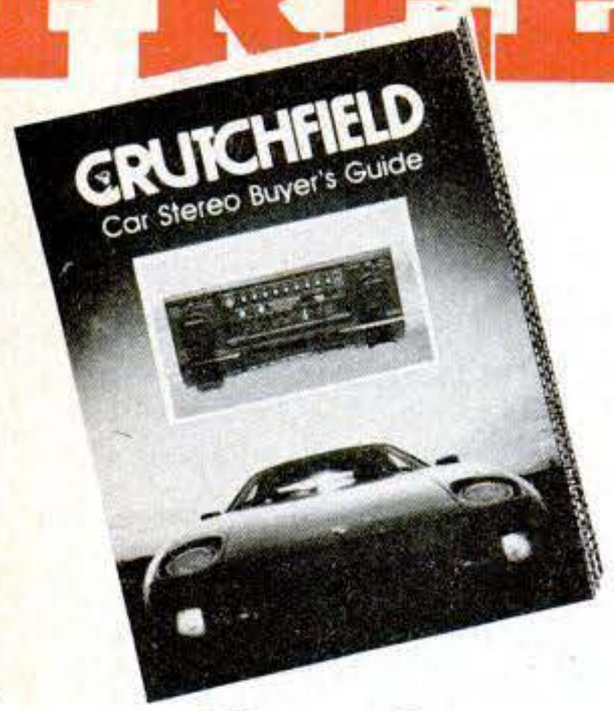

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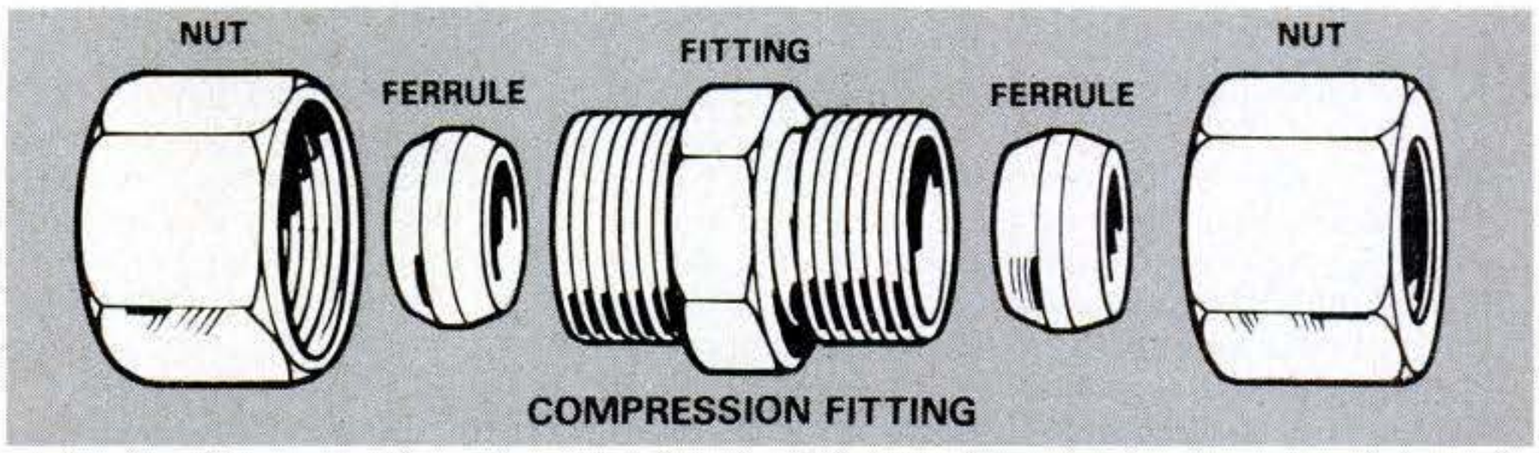
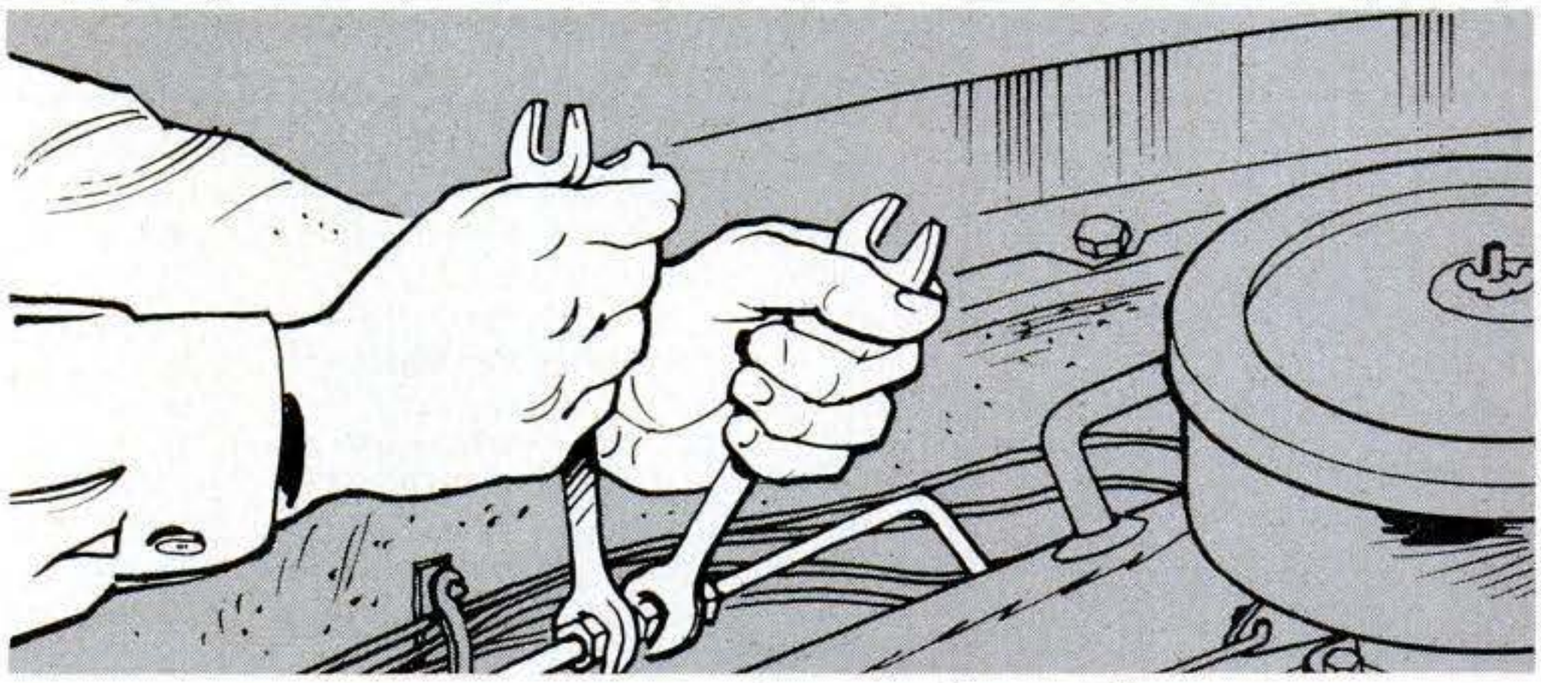
TAKING CARE OF YOUR CAR

By RAY HILL

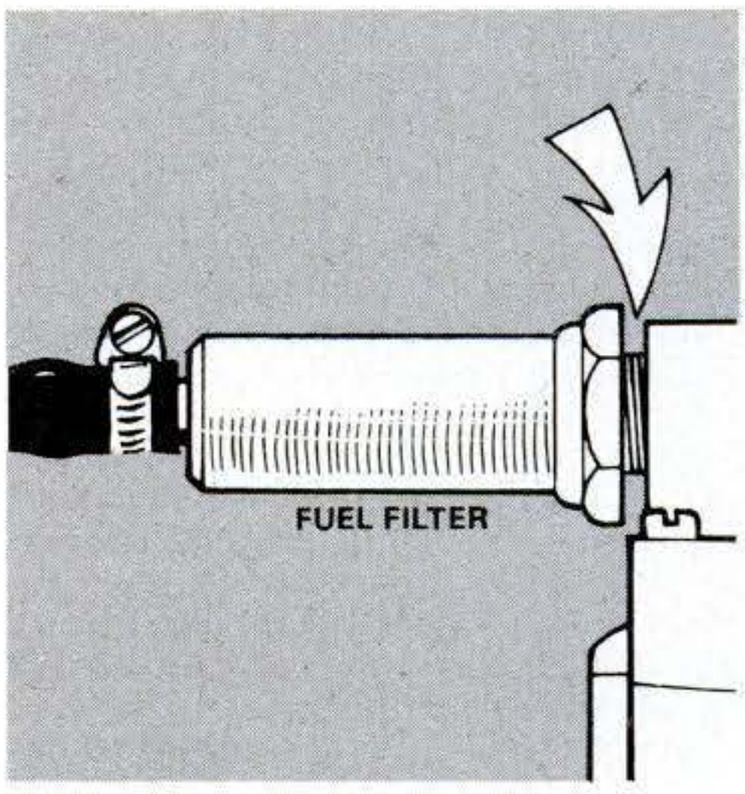
Got a useful car tip? Send it (with Social Security No.) to Car Care, Popular Science, 380 Madison Ave., New York, N.Y. 10017. We'll pay you $25 if we use it. If two or more readers send in the same usable tip, the one with the earliest postmark will be chosen. Sorry, but tips can't be returned.





Compression fitting may save a damaged metal line

A metal line that has been damaged may not need replacement. If the damaged area is fairly well confined, cut it out with a hacksaw or a tubing cutter, then join the ends with a compression fitting. These fittings are available in all common sizes. They will work on fuel, transmission-cooler, and vacuum lines. One caution, however: Never use a compression fitting on a brake line.



Tightening a fuel filter

Some cars use a fuel filter with tapered pipe threads that screw into the carburetor inlet. Because of this, some threads will show after the filter is tight. Don't try to screw the filter in all the way; you will strip the threads and may damage the carb. Replace the fuel filter at every tune-up (or as the maker recommends) to avoid clogging problems.

Take a picture of it

Removing a valve cover? If a lot of wires, brackets, and other items must be removed, taking a few shots with an instant-picture camera may save you a lot of grief at reassembly time. Refer to the pictures for wire routings, bracket locations, etc. The technique is also useful for other disassembly/reassembly jobs that you may not be entirely familiar with.

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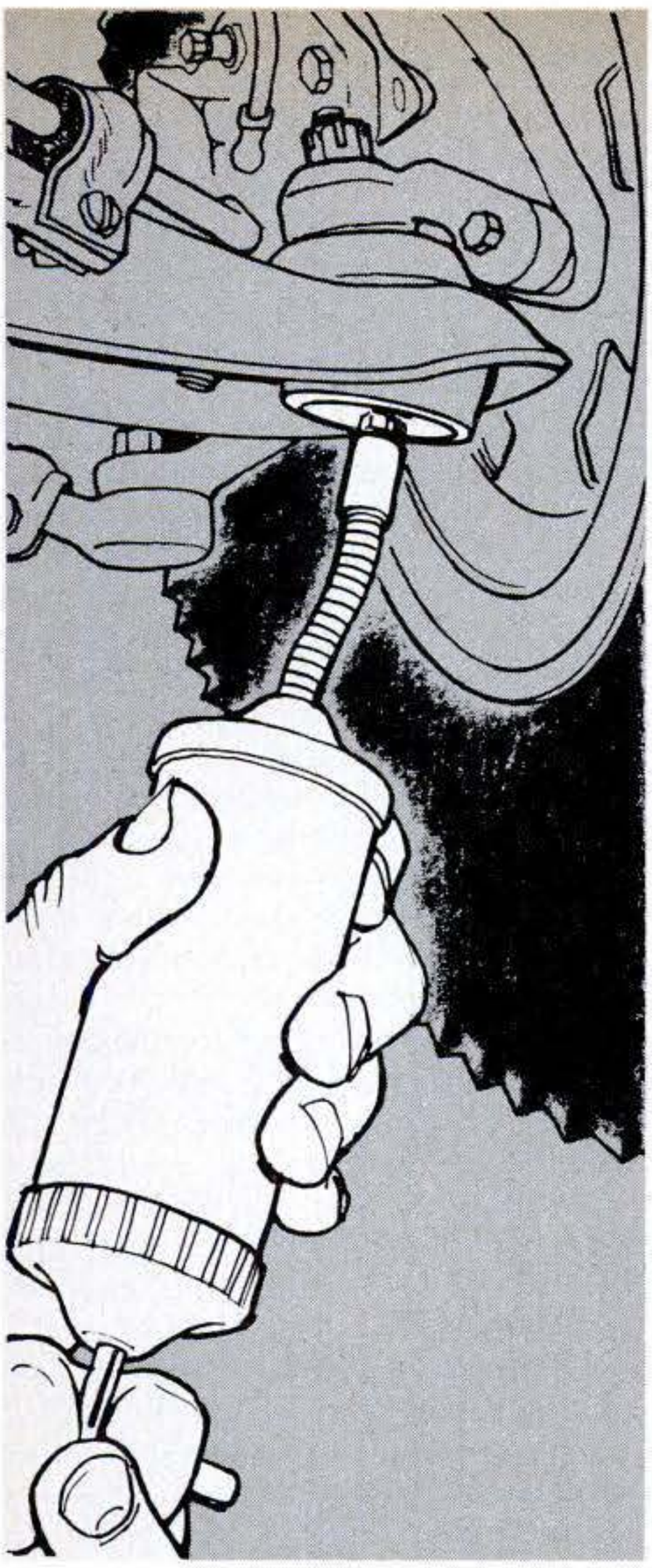
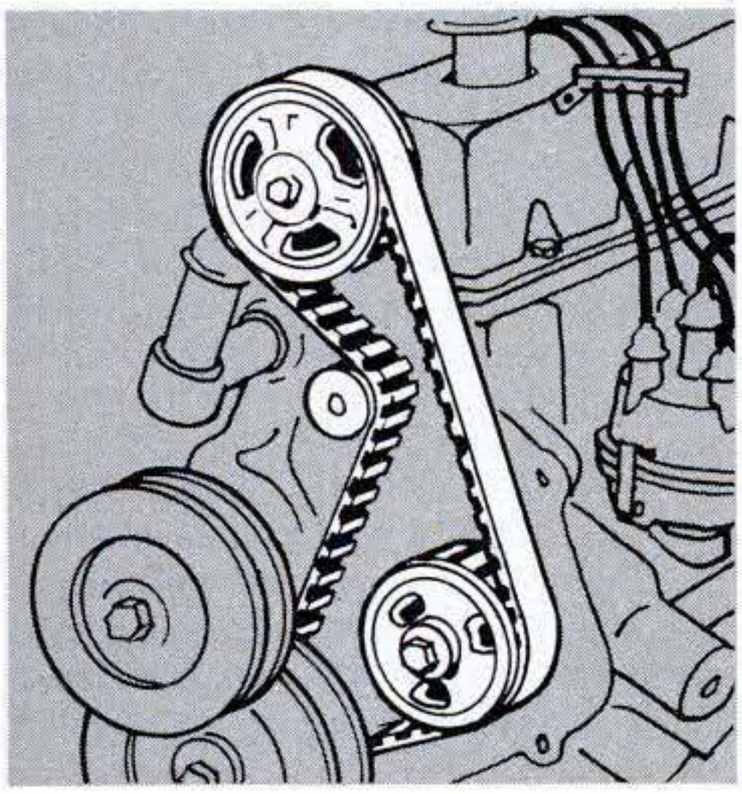


Grease may cure a squeak

A squeaking noise that occurs whenever your car goes over an irregular surface may be caused by nothing more than dry ball joints. Try greasing them before you waste time searching further.



Rotating the damper pulley

Turning the crankshaft by using a breaker bar on the damper-pulley nut is an easy way to turn the engine over slowly on many cars. But if your engine has an overhead camshaft that's belt-driven, don't turn the pulley in a direction opposite to the engine's normal rotation. This can cause the camshaft belt to jump a tooth or two, upsetting valve timing.

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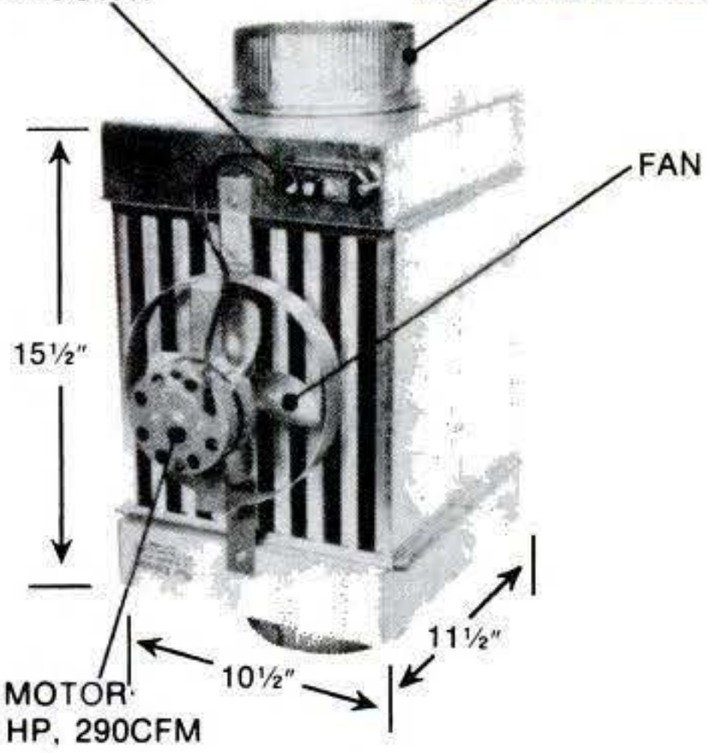

Note: Unit can be mounted horizontally or vertically.
Total wt. 16 lbs.

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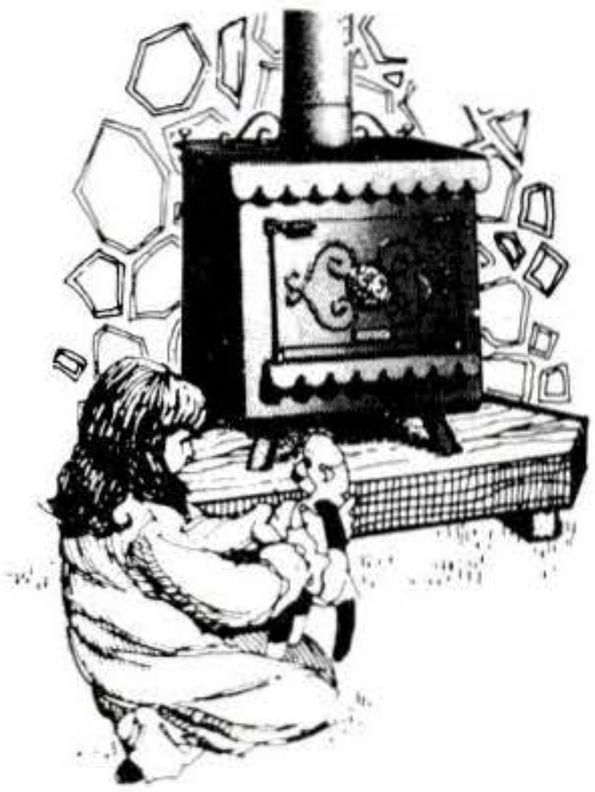

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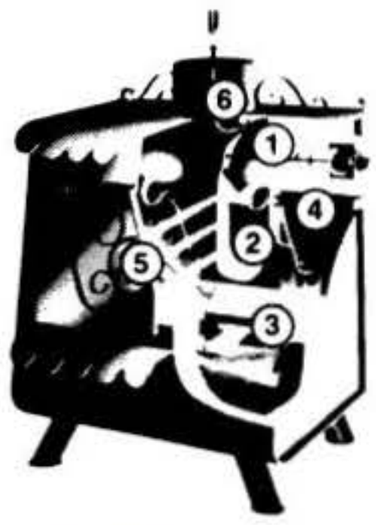

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Starting system

[Continued from page 130]

floor-test it (see diagram). If it runs poorly or not at all, your suspicion is confirmed.

To take the starter apart, remove the through-bolts. Remove the end plate to see if the brushes are caught in their hangers and not riding on the commutator, which can cause malfunctions. Inspect all critical parts to see if the unit is worth fixing. You can easily replace brushes worn to less than a quarter inch, but if the commutator is worn badly or out of round more than 0.005 inch (check with V-blocks and a dial indicator), it needs a pro. You can also make a few tests of the field coils and armature with an ohmmeter or powered test light (see diagram). Inspect the motor's bushings for wear and be sure to lube them before reassembly.

If you find anything wrong beyond worn or sticking brushes, you may want a rebuilt starter. That can cost $40 or more, so you can afford to do a little work on the old one. However, if you do a partial repair job, it's likely that something else will fail shortly.

Clean starter parts by wiping them with a solvent-dampened cloth. Don't immerse them in solvent; it can hurt electrical parts or cause a starter drive to slip.

New brushes need seating, so wrap the commutator with 2/0 or 3/0 sandpaper, abrasive side out, beneath the installed brushes. Rotate the armature a few turns clockwise, looking from the drive end. Blow out the dust before final assembly and, as you install the end frame, guide the brushes onto the commutator. If there's an indexing pin and notch in the end frame and motor frame, align them before drawing up the through-bolts. As a final check, make sure all brushes are free in their holders and riding on the commutator, and that their leads are not anywhere in contact with the rotating armature.

Starter drive. With a little tinkering you can sometimes fix a starter drive. A new spring may cure an inertia-type unit. The positive-engagement solenoid-operated starter drive takes more repair, though, and may have to be replaced as a unit. But you can clean its contacts.

If you get a rebuilt starter, renew any drive parts that don't come with it. Relays can also be tinkered with, but are so cheap that it's hardly worthwhile. Finally, when you bolt the starter onto the engine, make certain that the mating surfaces are clean, so they don't restrict current flow. PS

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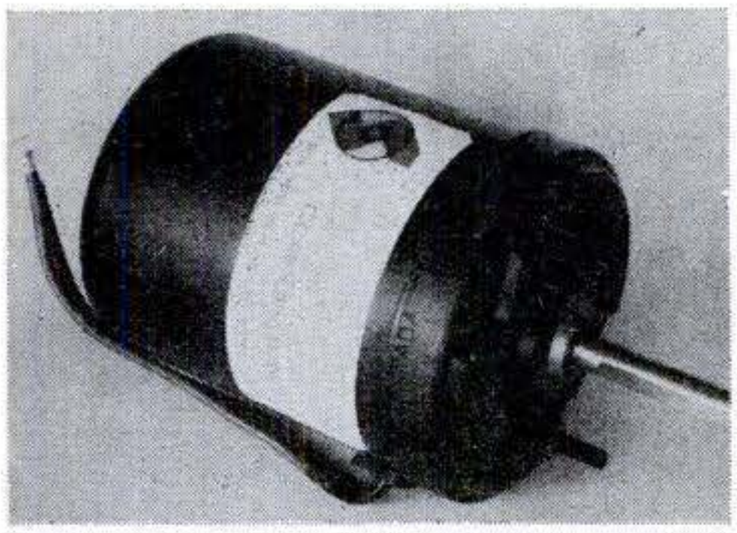

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SO EFFICIENT that it can produce 12 volts at only 475 rpm!

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How did such an unusual generator get built? Here is the story:

The TC25G began as one of many components, in a unique low-cost wind generator — the Helius Rotor kit. It was during the development of this rotor that our engineers discovered there was no inexpensive, low rpm generator to be found anywhere, that was suitable for small windpower converters — or, for that matter, for water wheels, pedal power, solar engines, fuel powered generators, or any other small energy needs.

It was tempting at the time to turn to "small" automotive alternators — which need several thousand rpm to generate the kind of voltage we wanted. They are large, heavy and also require an efficiency-killing step-up pulley to achieve the necessary rpm to generate power from a small water wheel or windmill. Meanwhile, the price of oil and other fuels was beginning to skyrocket and many people were clearly not going to take these price hikes lying down; more and more people were turning to *free* renewable energy sources — solar, wind, water — not because they *had* to, at that time, but simply because it made good economic sense. Needing to produce exactly the right product for the growing boom in home-sized alternate energy products, Thermax engineers started from scratch to design the perfect small generator. It had to be inexpensive, light, and operate efficiently at low rpm (which no other small generator could do).

The result of this design program was the TC25G permanent-magnet dc generator — which may be exactly the generator you've been looking for, if you ever tried to build a small water wheel or windmill.

Later, at the Energy Lifestyle Show, visitors who tried our demonstration generator were so amazed by its sensitivity that some even looked underneath to see if there was a trick to it! Turned only by a finger, the TC25G would easily drive a small 12-volt motor.

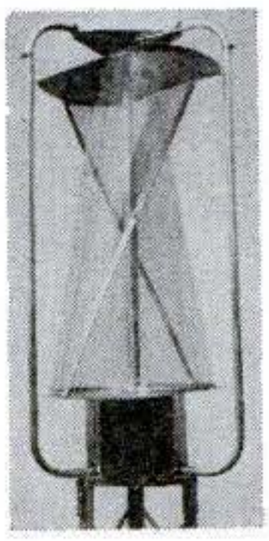
Many energy buffs bought generators on the spot.

At first the Thermax sales personnel were surprised that so many customers were attracted by the generator itself, and didn't want to buy the whole windmill kit. Even without advertising, inquiries kept coming from do-it-yourself energy enthusiasts who really wanted to build their *own* power systems, not Thermax's or anyone else's.

So here you are — the ideal small dc generator, with plans (if you need them) to build several different renewable energy converters. Now you can start generating your own free, natural energy!

FREE PLANS AND USER'S GUIDE

Order your TC25G now and receive, free with your generator, a complete applications guide: all you need to know about wiring, voltage regulators, batteries, inverters to step up to 110 volts ac, as well as plans for building the following energy producers:



HELIUS TC25K WINDPOWER CONVERTER

WATER POWER If water power is available you can build your own small hydroelectric generating station.

WIND POWER The TC25G is already standard equipment in Helius rotor kits. You can build your own wind generator from plans furnished.

PEDAL POWER Convert an old bicycle to generate power: pedal your television set!

SPECIFICATIONS: TC25G GENERATOR

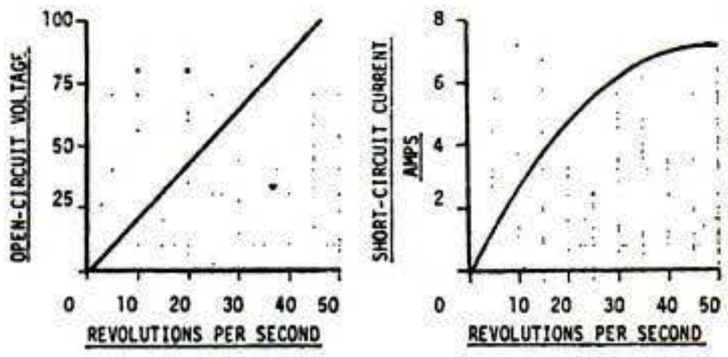
Two-pole permanent magnet dc generator.
Ten-slot armature wound with 0.4 mm (26 AWG) wire.
Internal resistance 7 ohms; heavy-duty long-life brushes.
Mounts by two 10-32 studs at shaft end of case.

Dimensions:

Case length	4 7/8 inch	(124 mm)
Case diameter	3 1/4 inch	(82 mm)
Shaft diameter	5/16 inch	(7.94 mm)
Weight	3.5 lb.	(1.6 kg)

Electrical Performance

Rated for 12 volts dc, will generate 6, 12, 24 or 32 volts with appropriate voltage regulator.



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"I was born in a 2 story and a half farmhouse and I still live in it. A good many winters we went a little short on wood and the house was pretty cool. There comes a time during winter in a house like this without any insulation and setting up on top of a hill with plenty of space behind it, that we close some doors and shut some rooms off. Because it stops the wind from blowing in one side and coming out the other.

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Clyde Chamberlin
East Lebanon, Maine

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Cast Eagle ornament available option.

No wonder, after half a century of burning wood, that Mr. Chamberlin chose the EAGLE to get the heat of a furnace for the price of a stove.

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Plug it in and go: CB radio

General Electric calls it "Help"—a 4
channel mobile CB radio designed f
use in an emergency. The hand-he
rig stows in a handy plastic box along
side its magnetic-mount collapsib
antenna—all neatly tucked out of th
way in the trunk.

But have a roadside emergency, an
the unit snaps to life: Simply plu
it into the cigarette lighter. That
the main idea, anyway.

Recently, on my vacation, I use
Help in a different way. I wanted
temporary rig for the trip—one I cou
install on the road and easily remov
at night or while sightseeing alon
the way. Help was a convenient, ine
pensive answer. The entire unit fits
your hand for talking, flops on th
seat while monitoring, and merely u
plugs for stowing. It has all the nece
sities of a full-sized rig: 40-chann
digital display, LED signal-streng
meter, squelch, volume, push-to-tal
and power—it's rated at four watts
the antenna. But it doesn't have th
bulkiness of a large rig or the batte
dependency of a walkie-talkie. It fa
between the two.

Although Help seems to be a go
on-the-road piece of safety gear, as C
intended, the radio will certainly be
use to weekend CB'ers, salespeop
(especially those who rent cars a
need a "quickie" installation), fam
lies traveling together in separa
cars, or anyone else who needs temp
rary communications. It's $115.95

W. J. Hawkins

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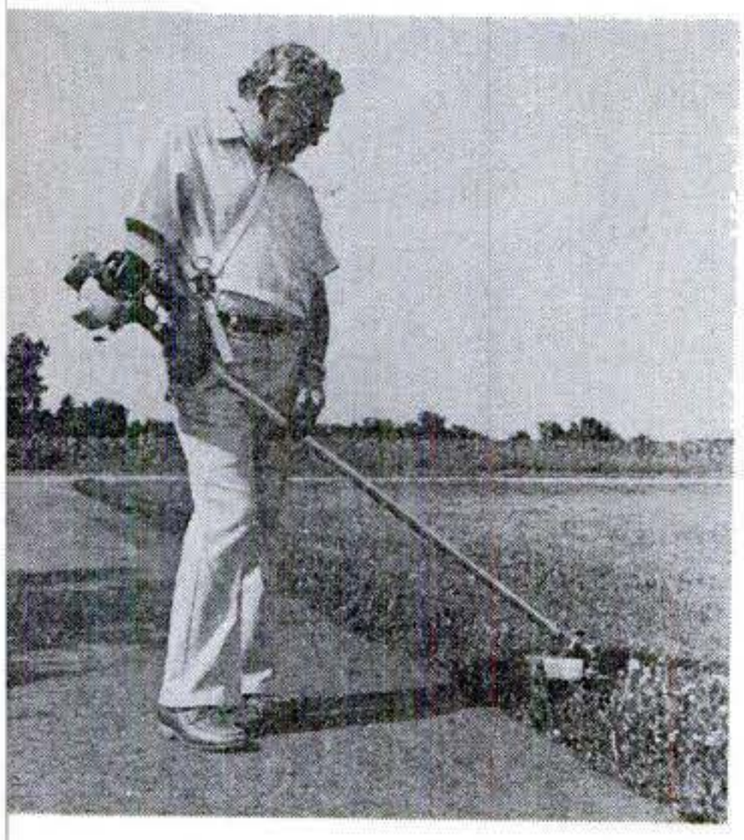
Trimmer/cutter uses blade or string



Engine-driven brush cutters are too heavy and bulky to lug around for routine lawn trimming. And trimmers light enough for family use seldom have the drive train to handle a brush-cutter or saw blade.

That's been my experience until now. But the Echo SRM-200DA changed my mind. It's billed as both trimmer and brush cutter. And it lives up to its promise. I tried the unit and was very favorably impressed with it.

Weighing less than 12 pounds, the new Echo balances comfortably without being tiring to use. The long shaft gets the cutting action well out and away from your feet. And an ingenious shoulder strap with a quick-release clip lets you detach yourself from the machine easily—very handy if someone calls you to the telephone.

A gentle tug readily starts the little 21.2-cc engine. It runs smoothly and with plenty of power. I especially like the heavy, 0.095-in. nylon cutter line. It's durable, and has the backbone to whack off even stalk-type weeds.

The engine has rugged ball and roller bearings throughout. The drive shaft is straight; it is not a flexible shaft. And the angle drive at the lower end works through a pair of spiral-bevel gears running in ball bearings in a sealed housing.

These features make the SRM-200DA husky enough to handle the optional eight-inch brush-cutter or 10-inch saw blade. Suggested retail price is $229.95. Echo, Inc. (Box 578, Northbrook, Ill. 60062) makes it. Echo also makes a lighter model with the same engine. It costs $179.95.—*E. F. Lindsley*

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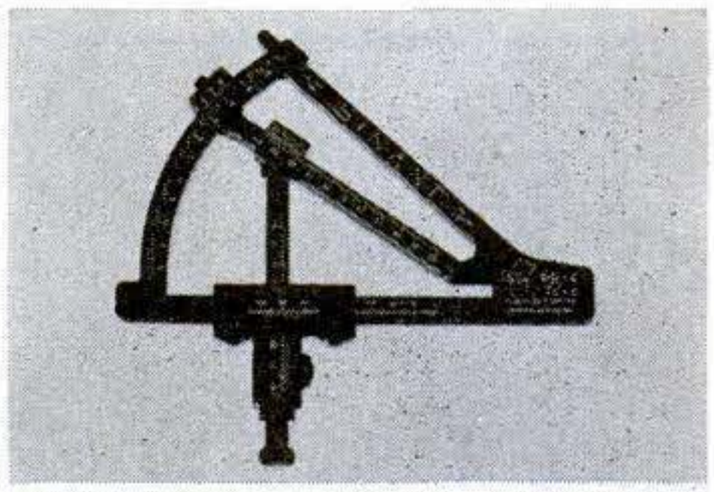
Pivoting slide rule
figures all the angles



It looks like a sextant, but it's actually a geometric slide rule for construction engineers. According to the inventor (Gerhard Stuhm, Mullerstr. 133, 1000 Berlin 65, Germany), the rule liberates on-site engineers from tables or formulas needed to solve right-angle problems with two unknowns. The fixed horizontal-base scale records the width of roof or bridge; the pivoting diagonal arm marks the pitch of roof or steel diagonals. This hinged arm swings across a quadrant that gives elevation in degrees.

A builder using the slide rule to figure the length of roof timbers, for example, first swings the pivoting arm to the proper degree mark for the roof pitch desired. Next, he pushes the vertical slider to the number on the horizontal scale that corresponds to the width of the roof's base. These adjustments set the scale on the pivoting arm to the correct length for sloping timbers. The setting on the vertical slider itself gives the proper length for uprights.—*David Scott*

Conical clips

Flexible plastic cones make droll, but efficient, clothespins. Double-slotted to grip heavy items, the ribbed cones can also hold two lightweight garments side by side on the line. When nested for storage, the ribbed cones cling together, so the whole stack can be suspended from the line. Rain won't pool in the inverted cones—each has a tiny drain hole in its tip. They were invented by Clive Joseph (Box 425, Crows Nest, N.S.W. Australia, 2065). The compact clips would be especially handy for travelers.—*D. S.*

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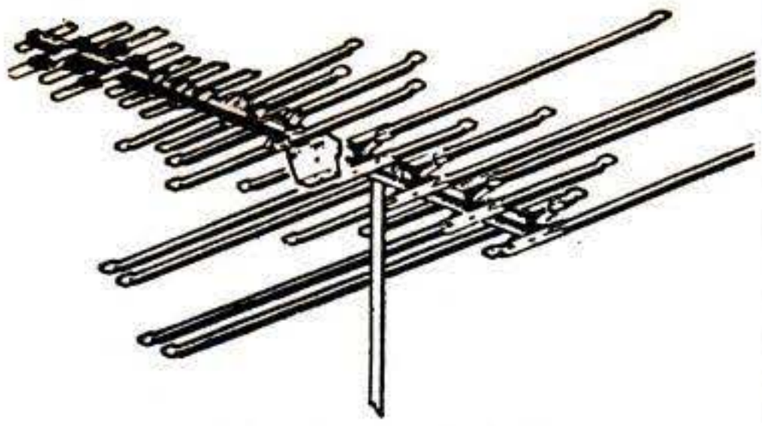

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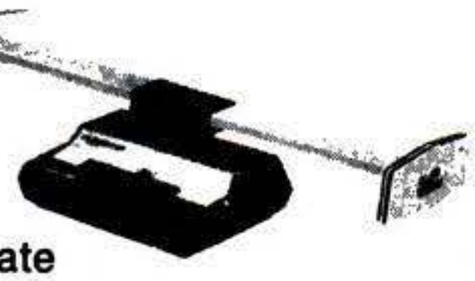

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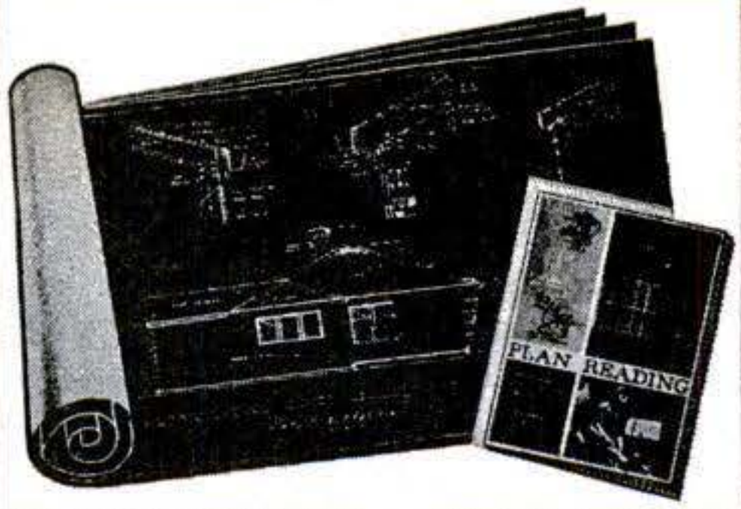

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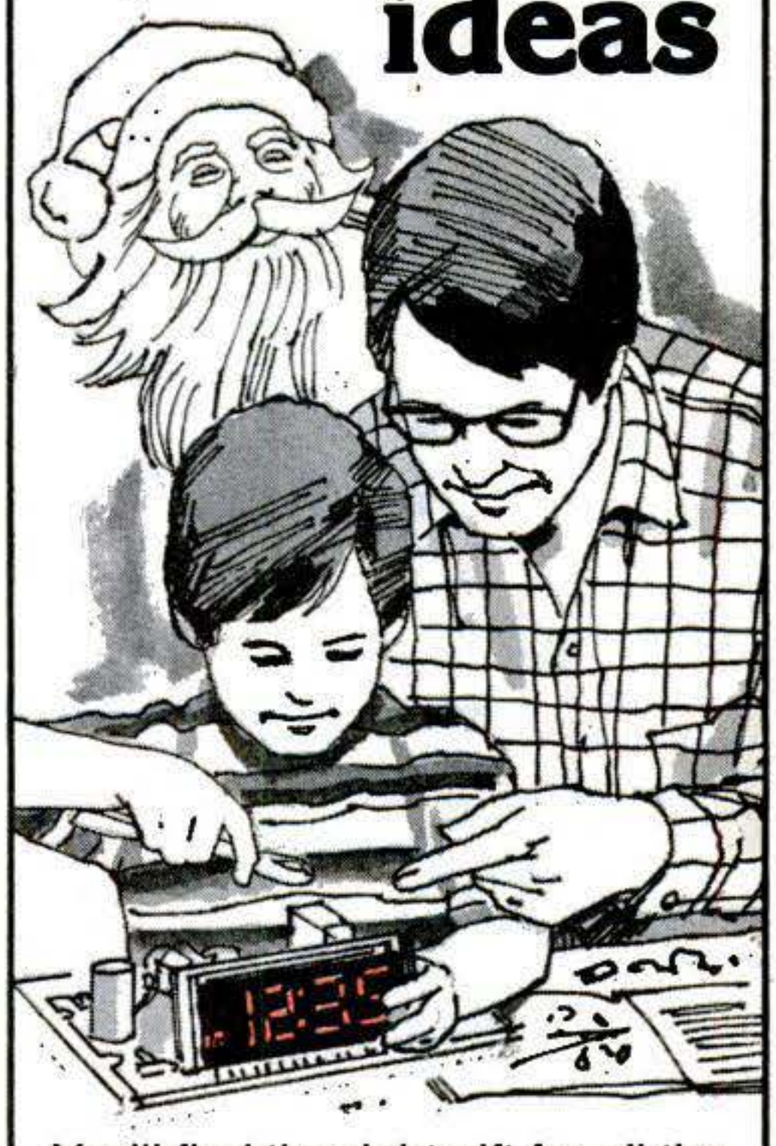

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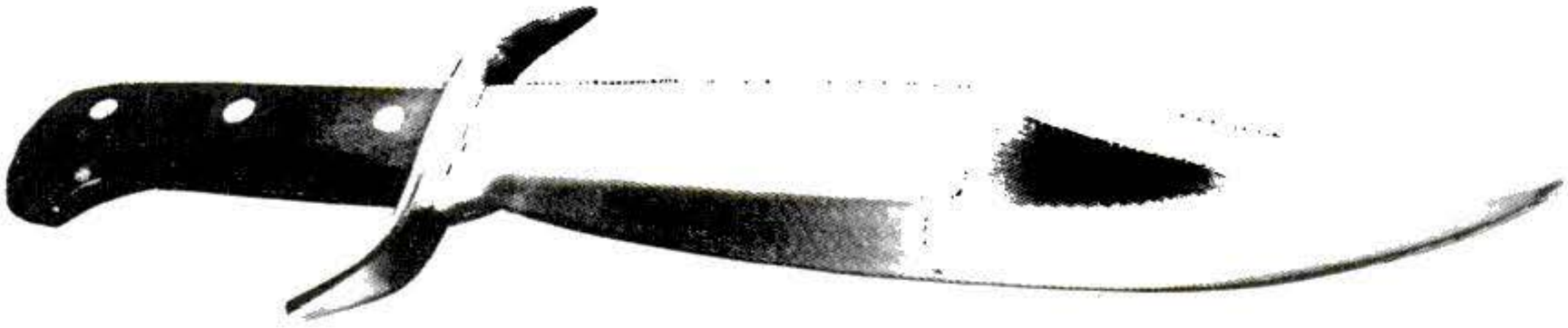
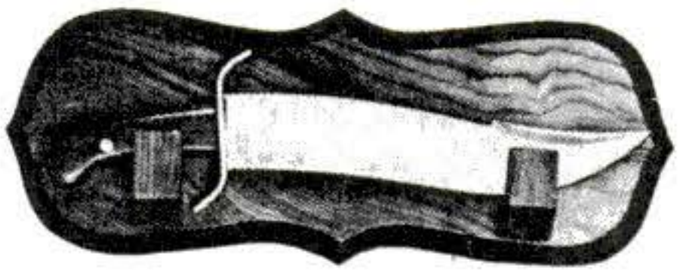
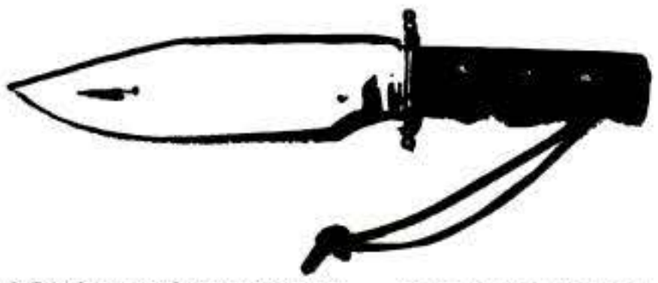


1. **BOWIE KNIFE** — This knife is an unusually handsome replica of the original American Bowie. The blade is 9½", and the handle a full 5". The guard is of solid Brass, and the handle is Rosewood. The knife is heavy, and the construction is of the type seen only on the most expensive knives. $15.95

2. **STILETTO KNIFE** — This ia a fighting knife, designed for combat. The blade is 8", the handle 5", and the guard of heavy brass. This knife can be used by the hunter and fisherman who are attracted to its unusual design and beautiful symmetry. $15.95



3. **MARTIAL BOWIE KNIFE** — Is of similar quality to the traditional Bowie, however the blade is 11" and the design is completely original. This is a massive knife, its unique design appealing both to the collector and the sportsman. $15.95



4. **COMBAT BOWIE KNIFE** — This knife has an 8" blade, 5" fingergrip handle and a leather wrist thong. This blade is unusually heavy and sharpened on both sides, as is any true combat knife. This all-around field companion is similar to the knife issued to America's front line troops. $15.95

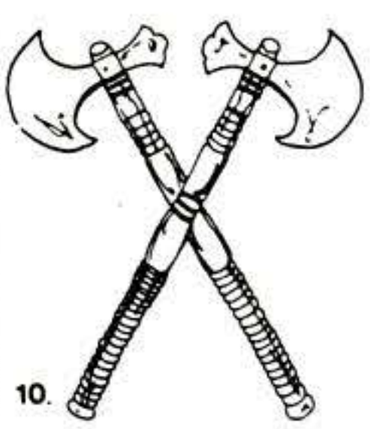
5. **SHEATH** — We are also offering a Sheath for all 4 knives, of unusual quality. The leather is beautifully handtooled and substantial. The fittings are of Brass and the rivets of Copper. $5.95 each

6. **PLAQUE** — You may also be interested in the Plaque for all 4 knives. It is of solid Teakwood, beautifully finished, and would be a credit to your den or office. $9.95 each

7. **DOUBLE-HEADED BATTLE AXE** — 31" long, is truly exquisite. The handle is of carved Rosewood, and the beautifully ground steel heads ring with the flick of a finger. The head is almost 11" from edge to edge. $29.95

8. **SAMURAI SWORD or KATANA** — This reproduction of Japan's famous sword is full size, full weight and the blade is forged and ground. The guard is solid brass and the handle is wound in the traditional manner. This famous weapon will enhance the decor of your den, mantle or office. $39.95

9. **CLASSIC TOMAHAWK** — Imported by the French originally to trade for furs with America's northeastern tribes. This reproduction will fascinate the serious collector of early Americana. $14.95



10.

11.

10. **WAR AXE SET** — With a 6" blade and a 17" handle. They are hand-forged and sharpened by the tribesmen of northern India, and are similar to the weapons used by these northern Indians to oppose Alexander the Great and later their British conquerors. The handle is beautifully tooled and the blade is heavy and tapered. $29.95 Set

11. **SHORT SWORD SET** — These ornate swords are 18" overall with a brass-handled horse head and guard. They are very beautiful and should be seen in color to do them credit. This set will prove itself an attention-getter, and will have strong appeal for decorators looking for the unusual. The scabbard is brass and velvet and most attractive. $29.95 Set with scabbards

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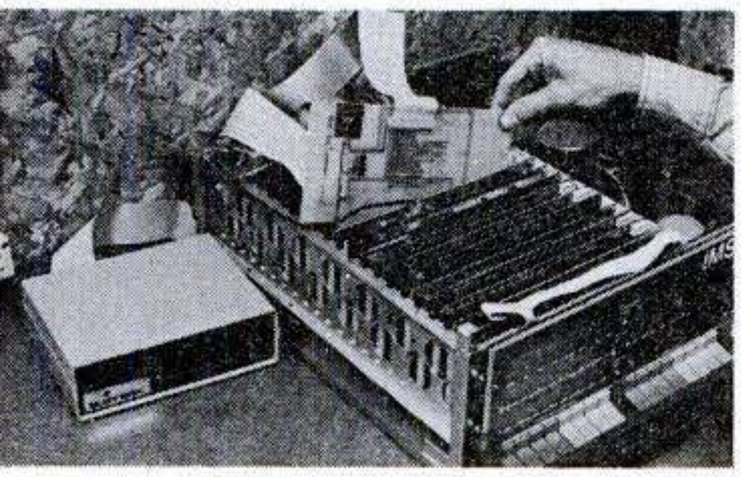
Plug-in remote control for your home computer



Two parts: Busy Box unit is wired to an S-100 circuit board that plugs into the computer for power and control signals.

Your home computer is probably the most intelligent "appliance" you own. But brains aren't everything—when it comes to physical labor, your toaster is better qualified.

Now, however, you can give your computer some muscle. With Busy Box, your computer can remotely control any light or appliance in your home. At night, it can set night lights and flip on the TV at the right time. By day, it can start the coffee, turn on the hi-fi, and start the sprinkler.

The Busy Box is actually a wireless connection between a standard S-100 computer and a BSR X-10 ultrasonic remote controller. You program the Busy Box with simple commands (such as in BASIC: OUT 99, 2) to send ultrasonic tones to the BSR command console. The console then works in its usual way to send an RF signal through your existing house wiring to the module controlling the appliance or light. Result: computer-controlled remote control—without wires.

The Busy Box can be programmed to mimic all the BSR codes, so you can make your program dim or brighten lights, or you can use the "all lights on" command—when your program detects an intruder, for example.

The S-100 version is $119.95 (TRS-80 and Apple II versions available) from MicroMint, Inc., 917 Midway, Woodmere, N.Y.—*W. J. Hawkins*

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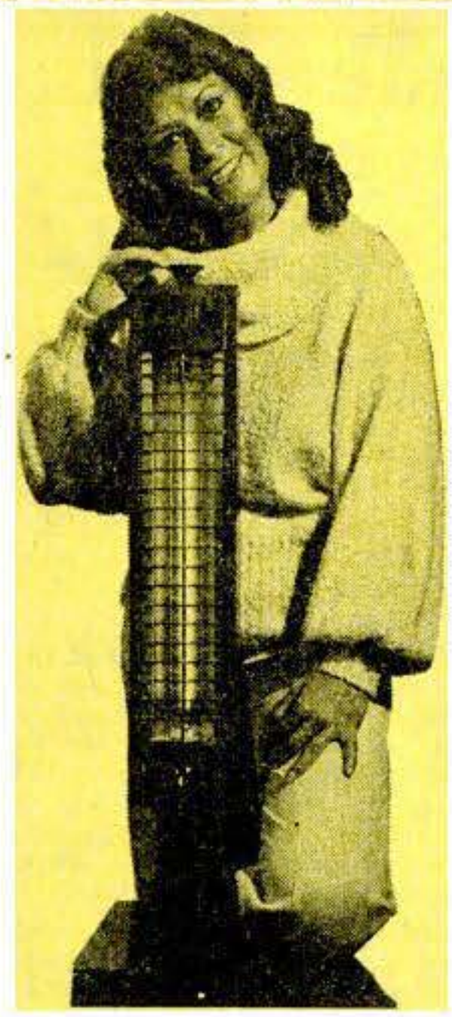

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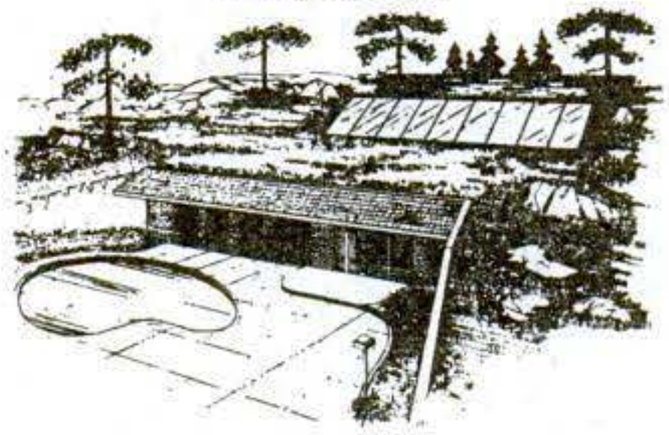

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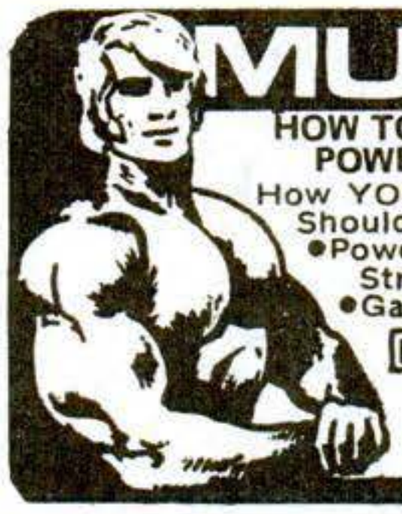

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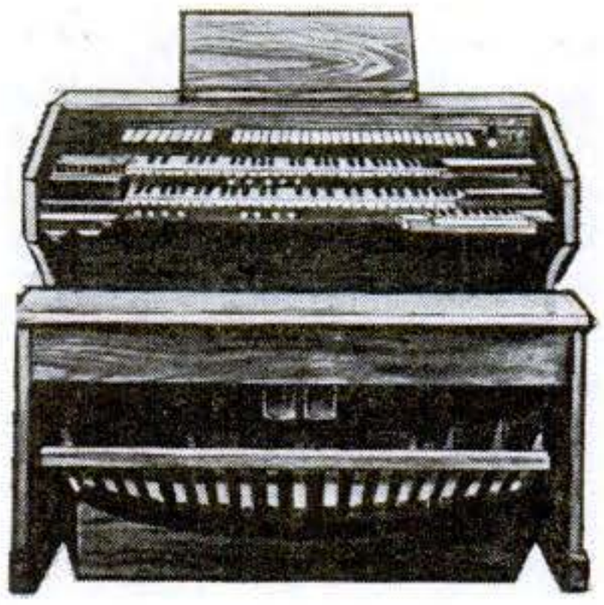

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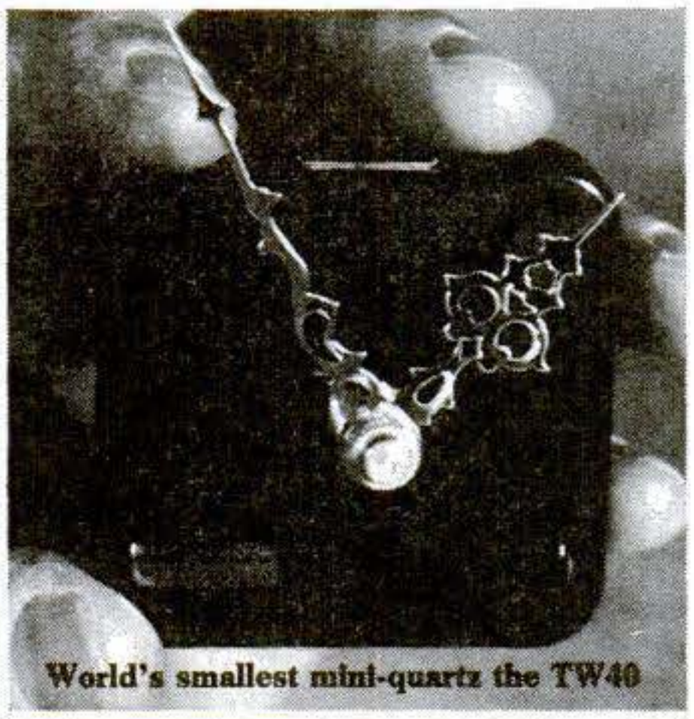

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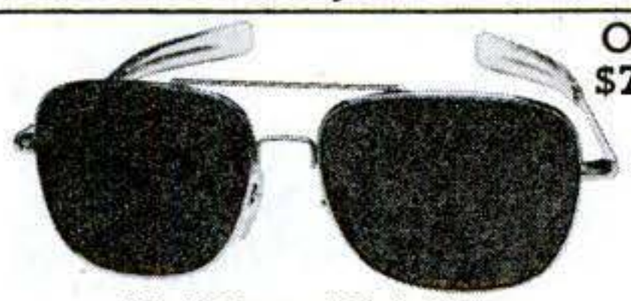

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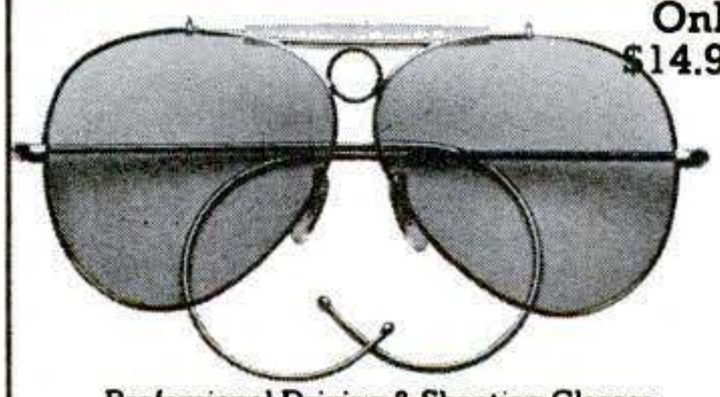

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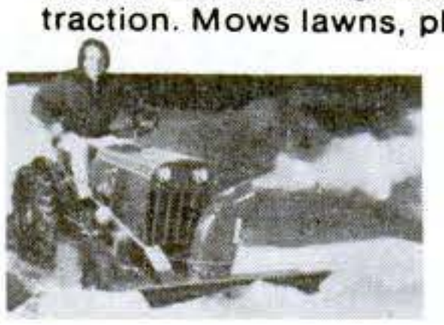

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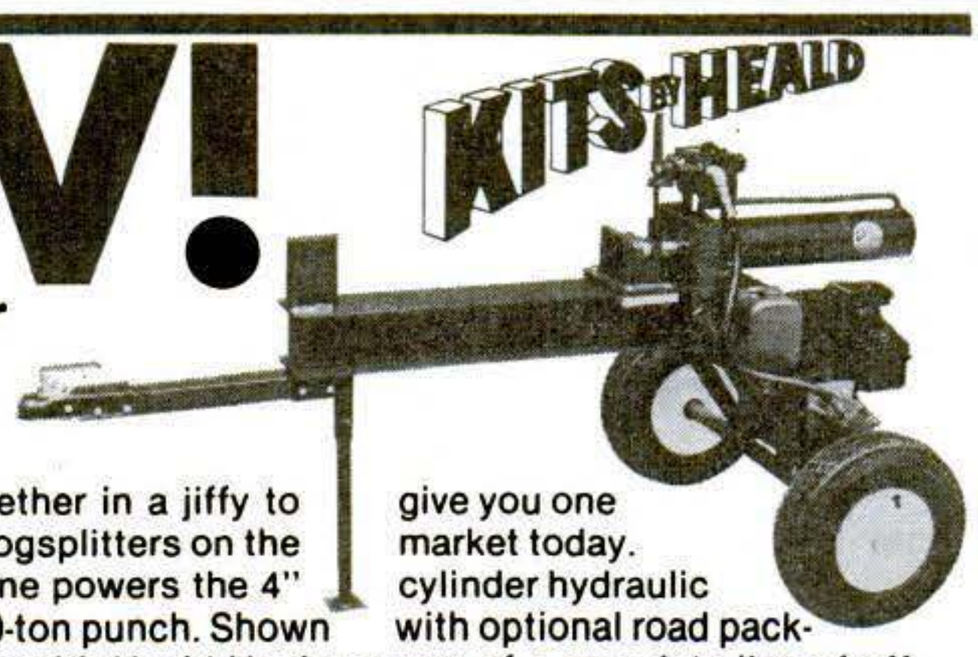

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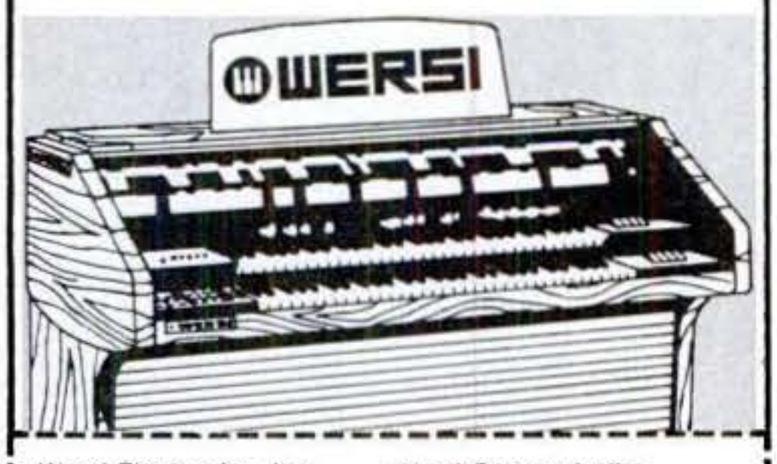

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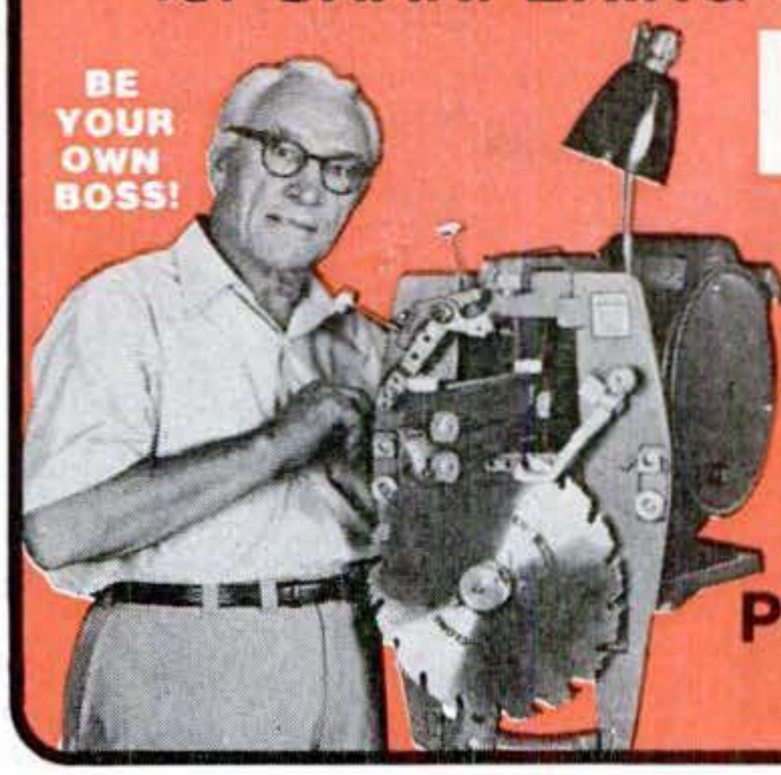

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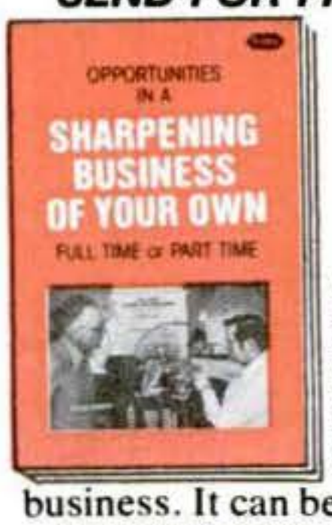

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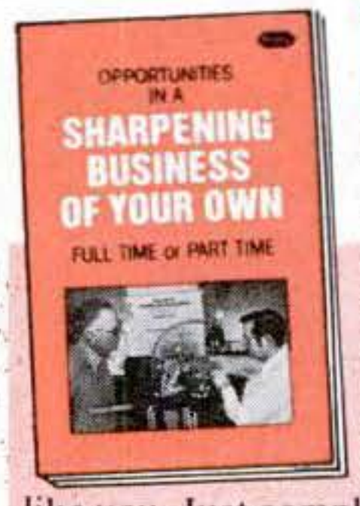

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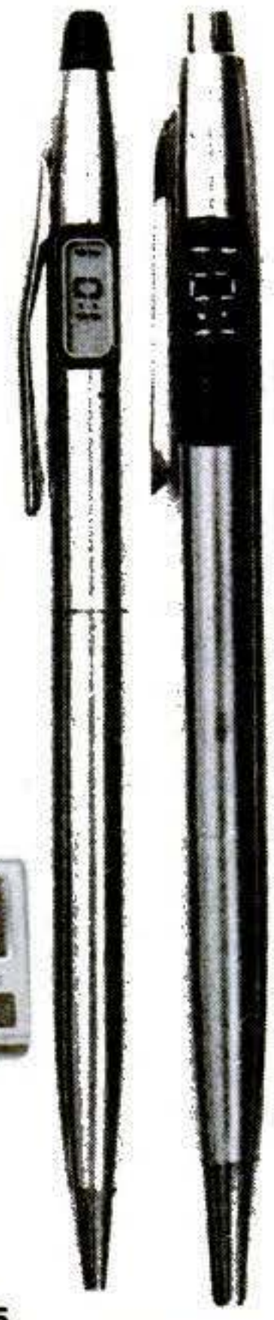

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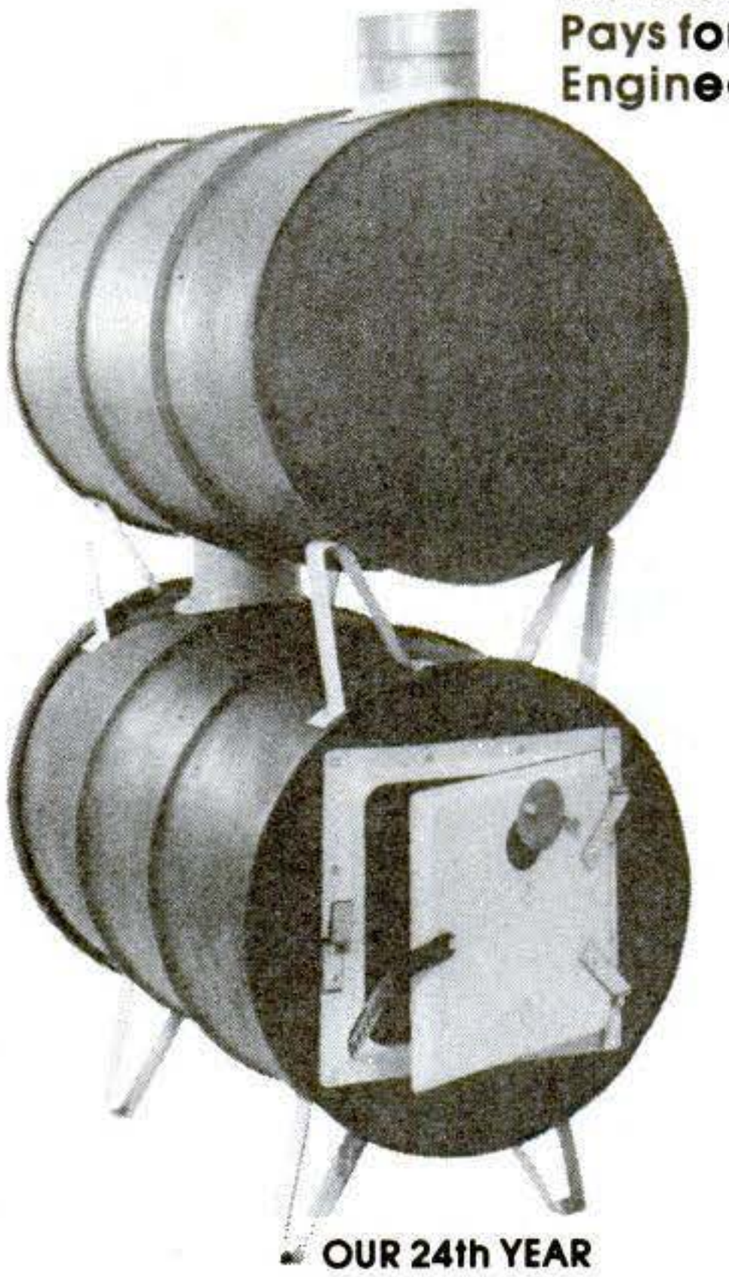

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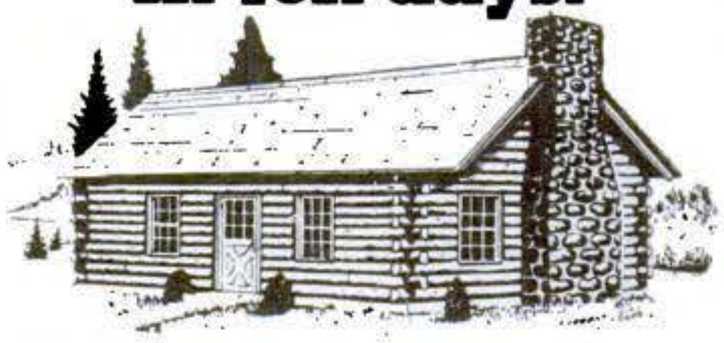

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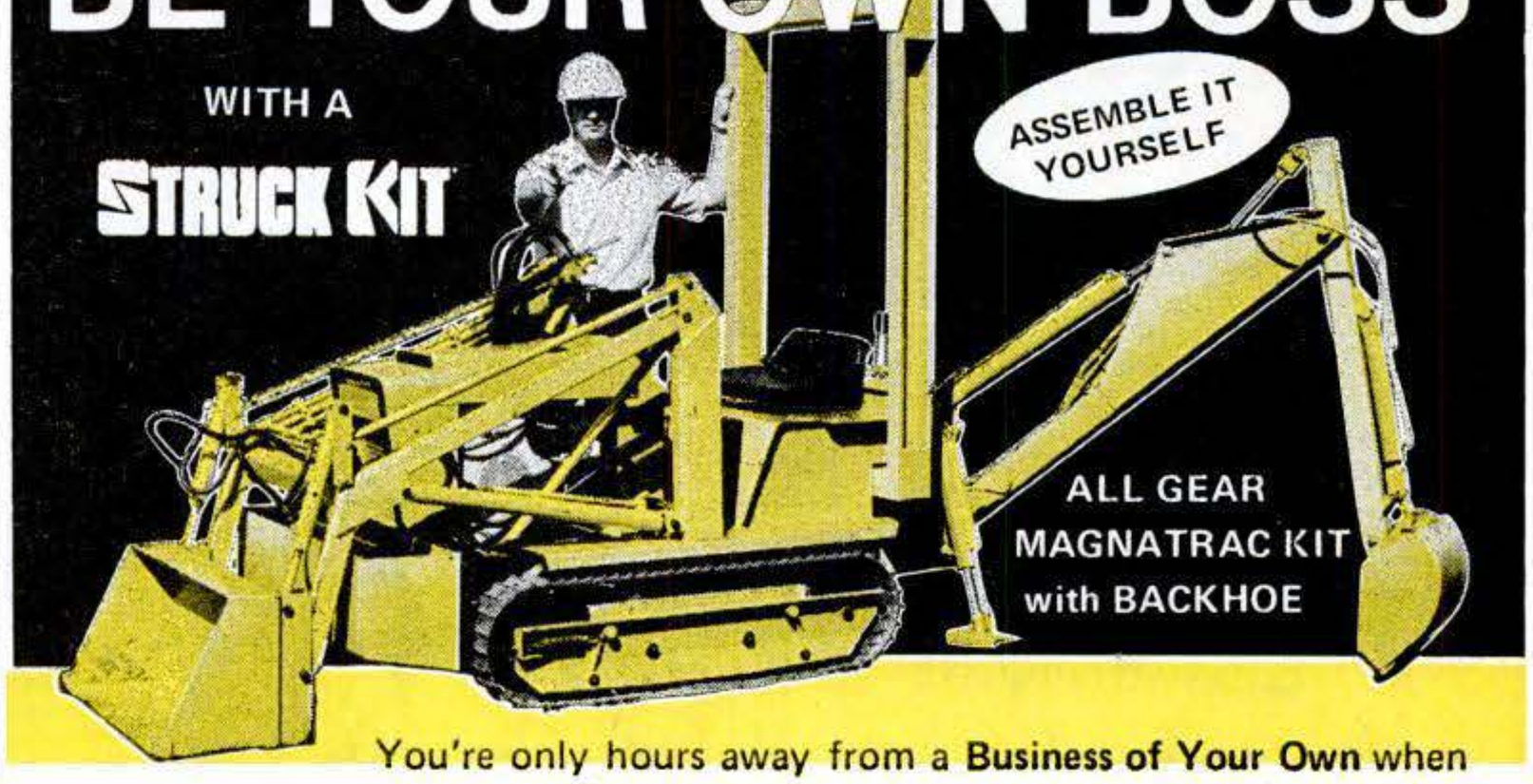

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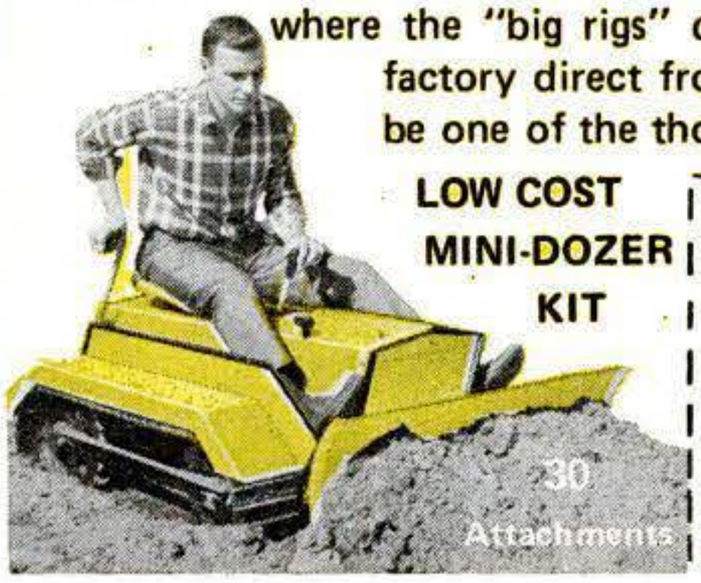

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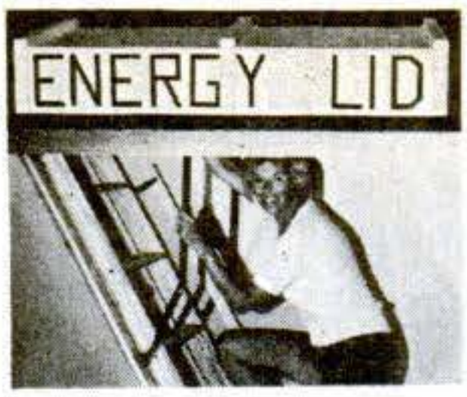

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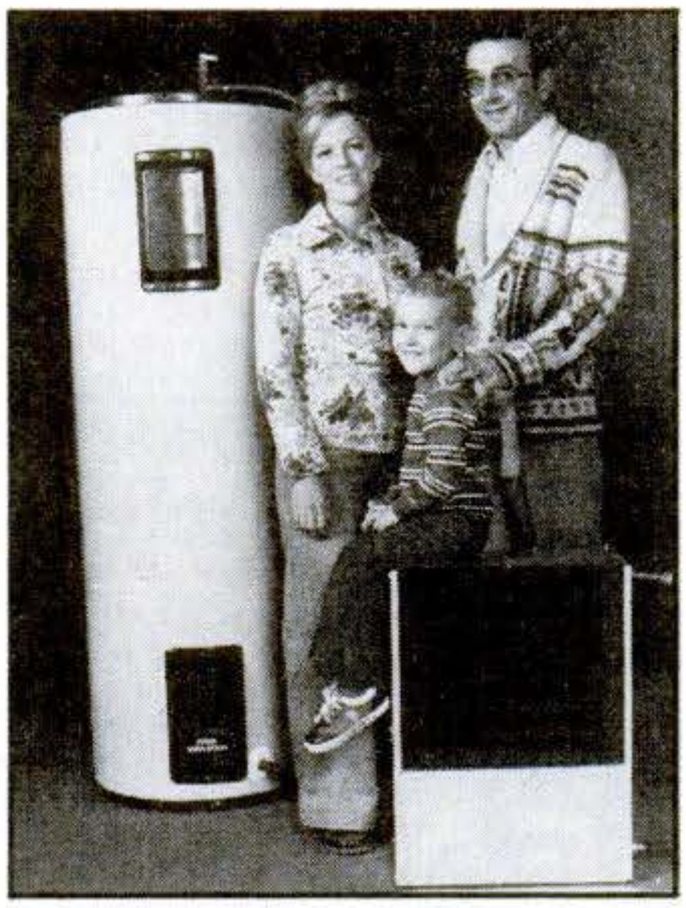

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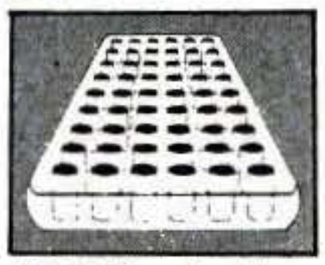

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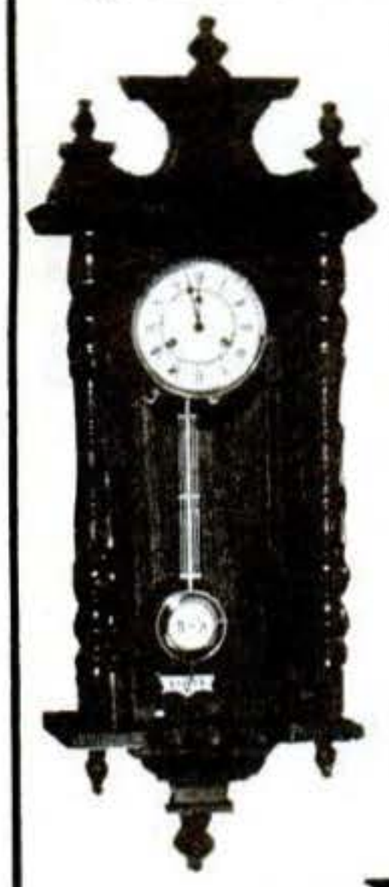

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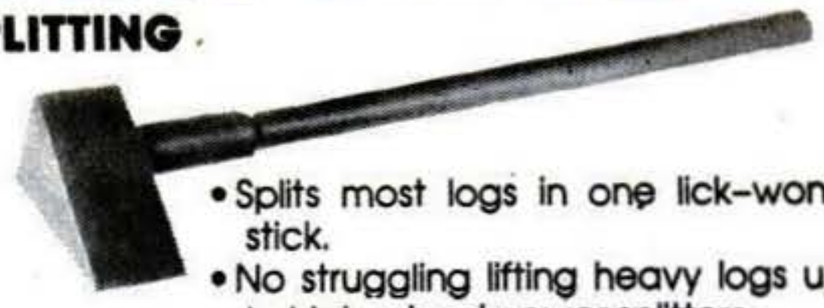

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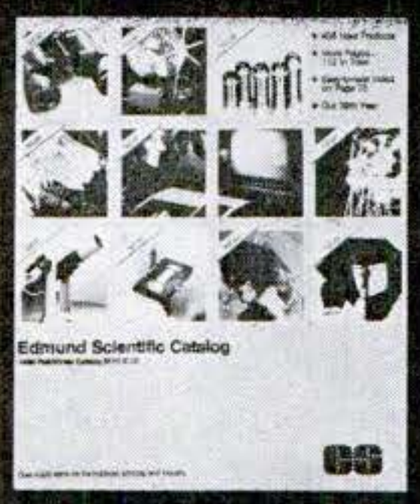

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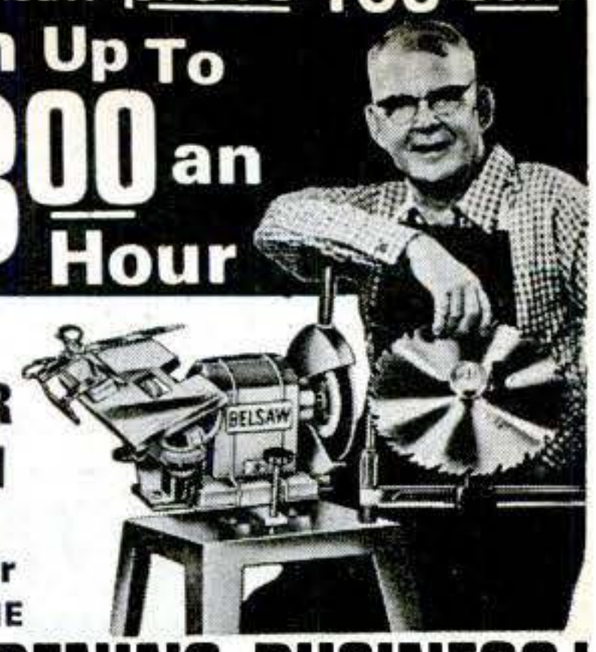

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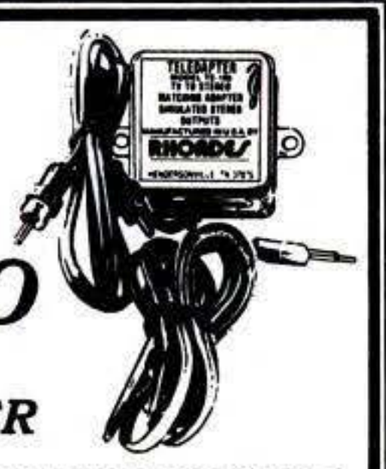

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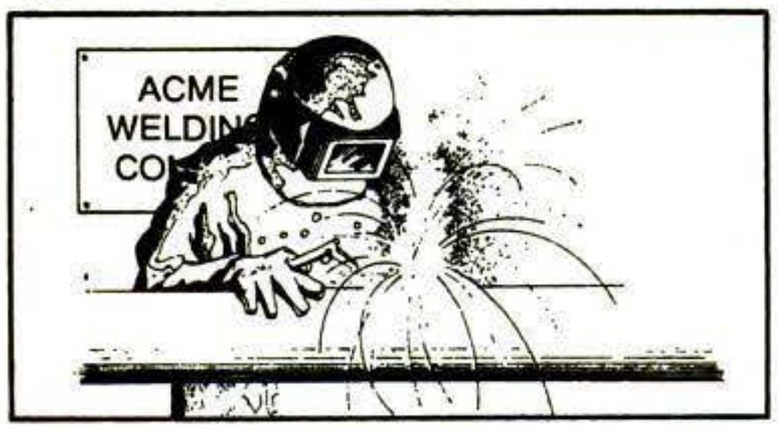

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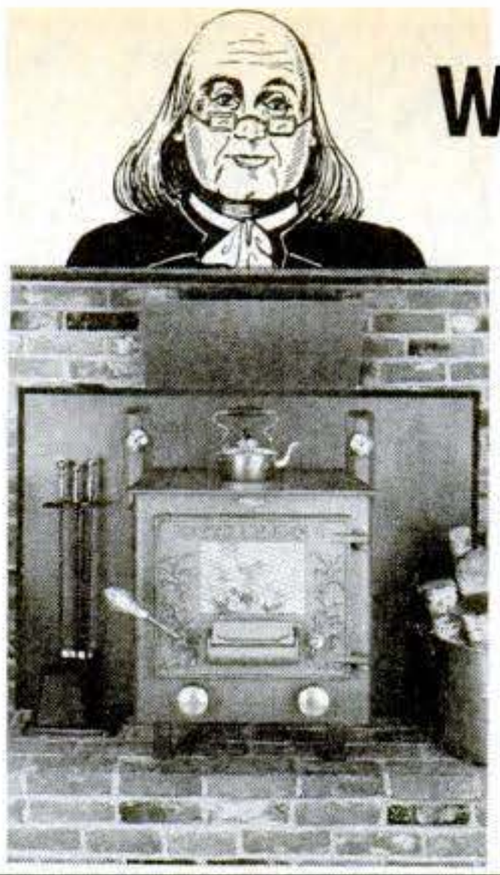

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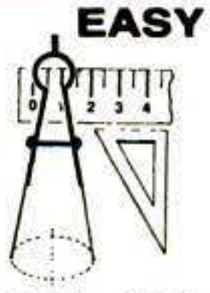

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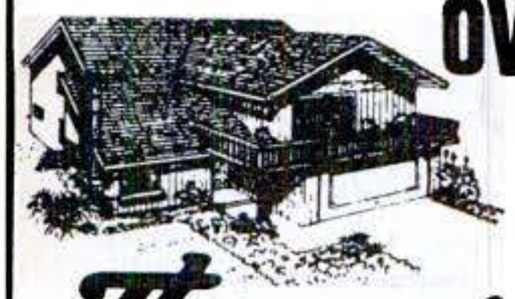

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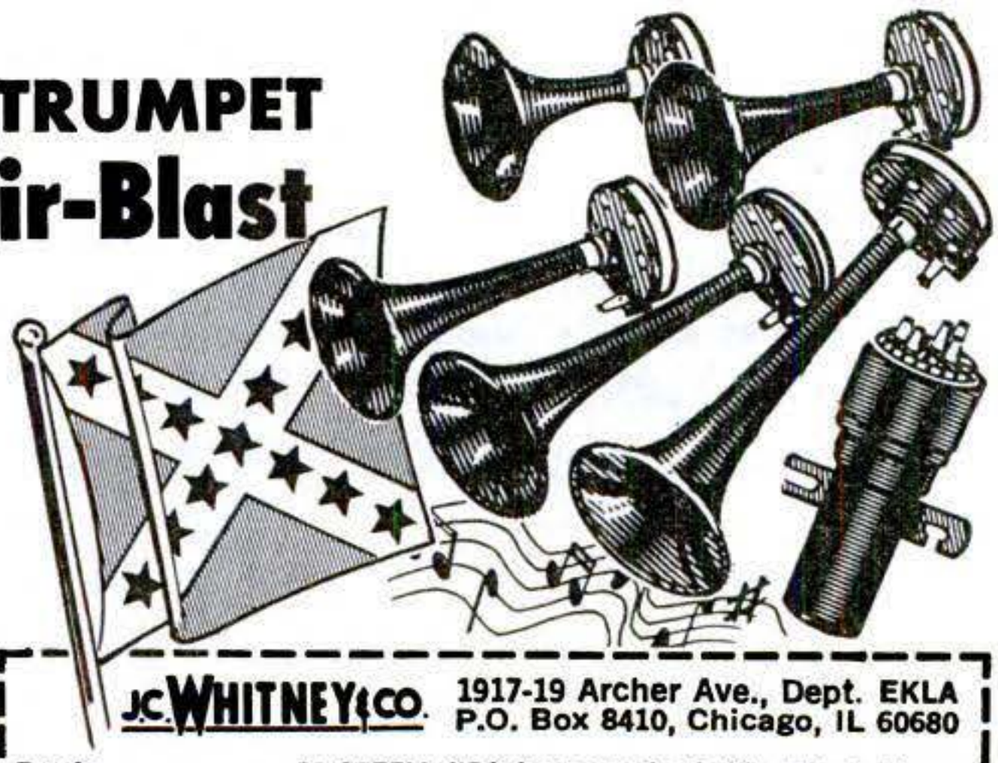

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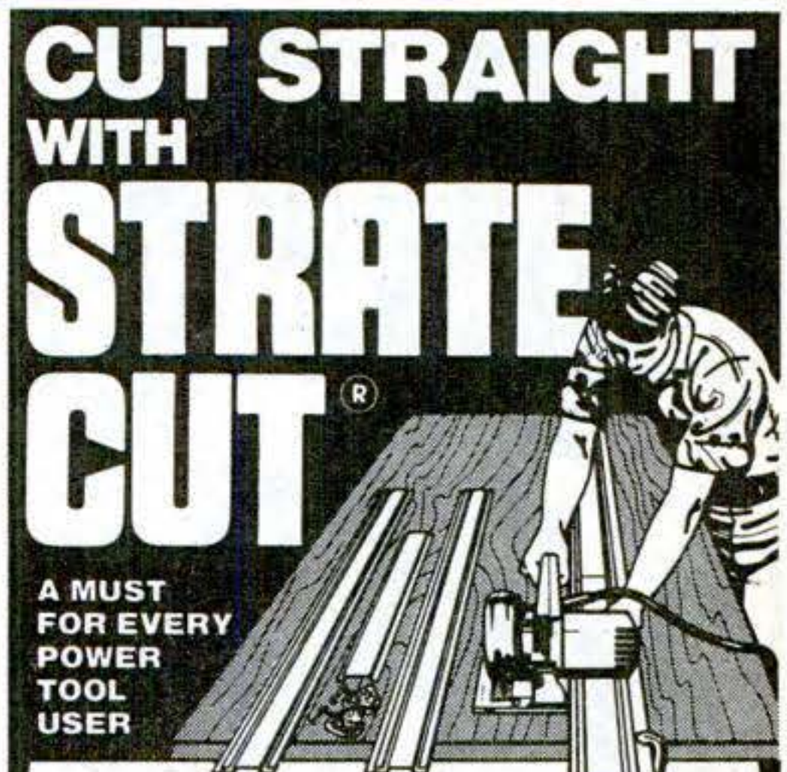

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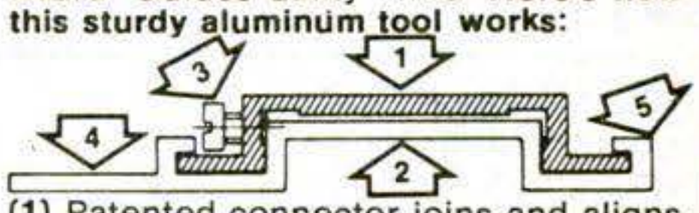

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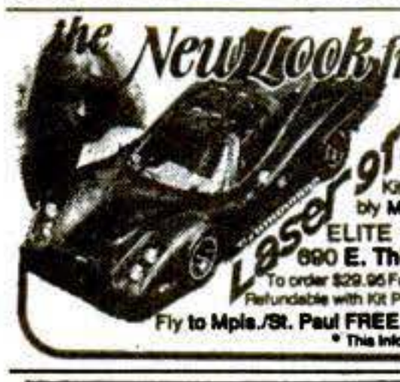

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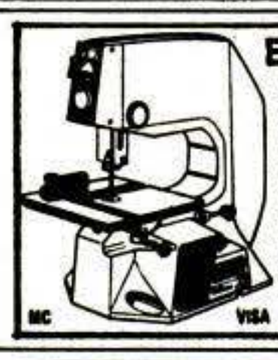

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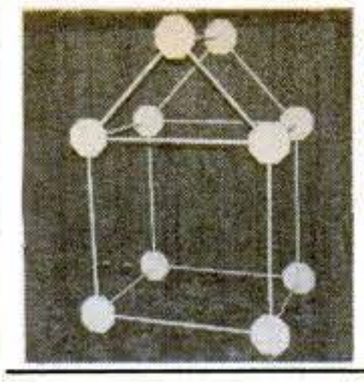

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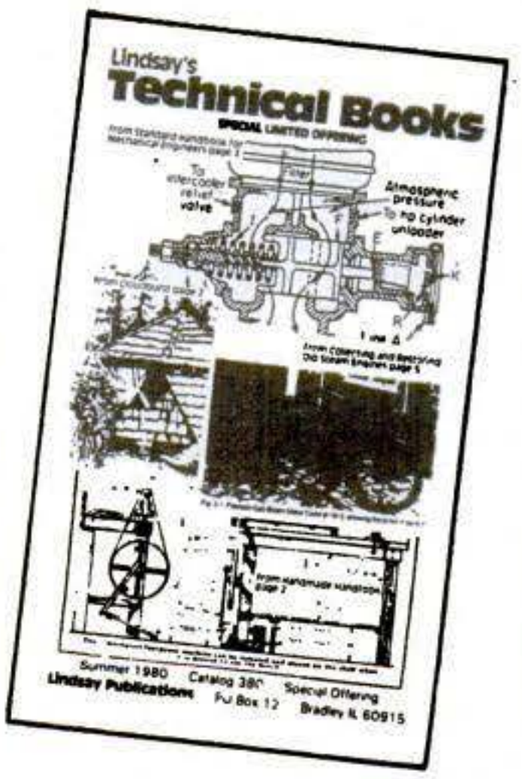

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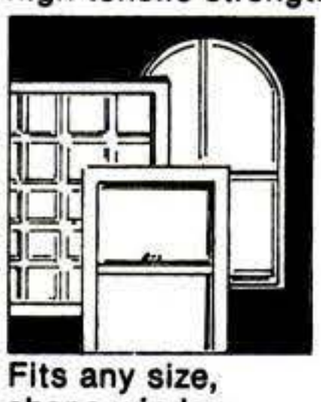
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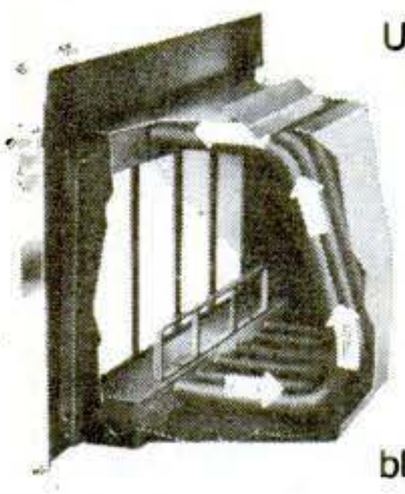

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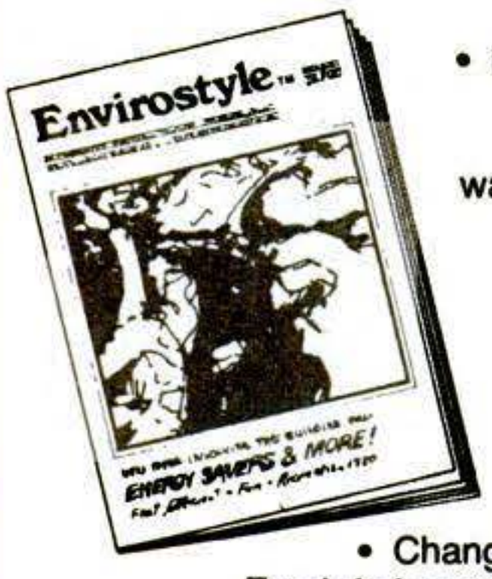

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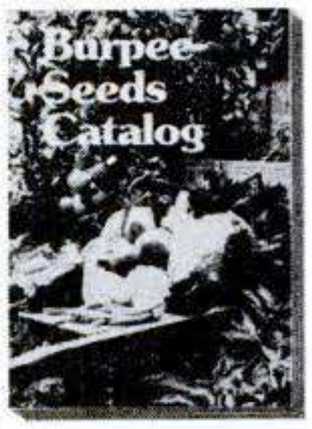

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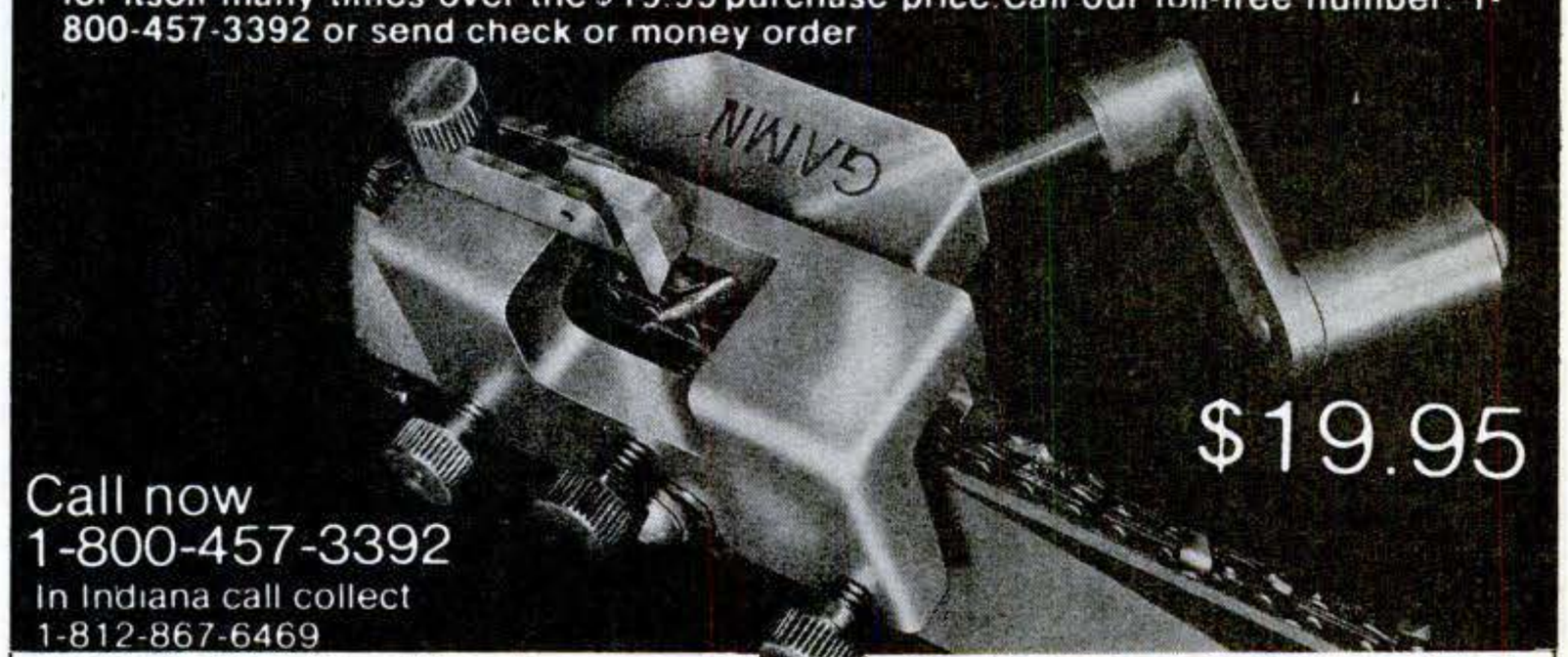

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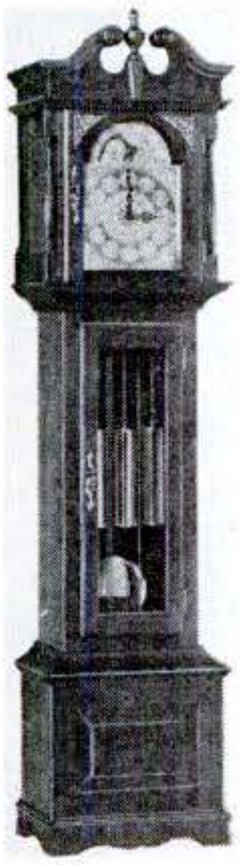

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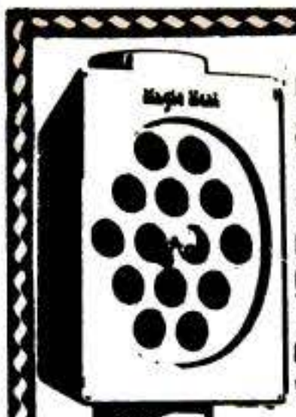

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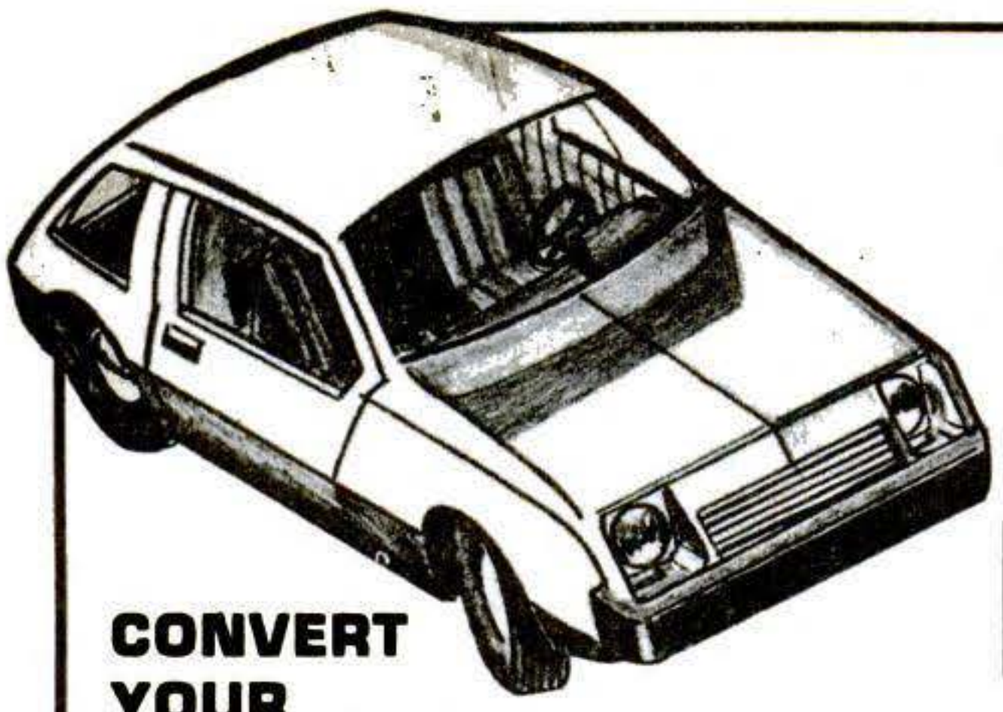

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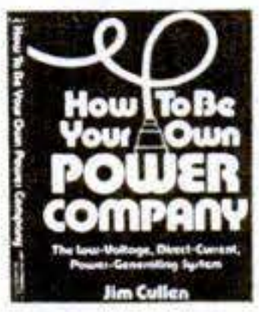

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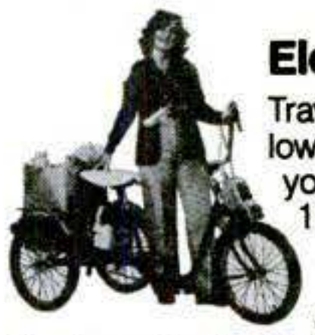

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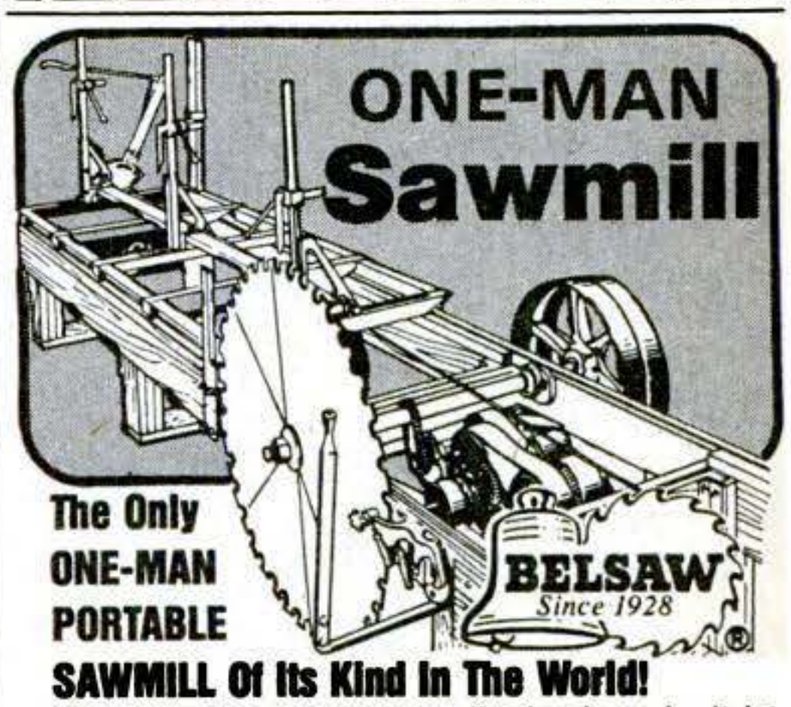

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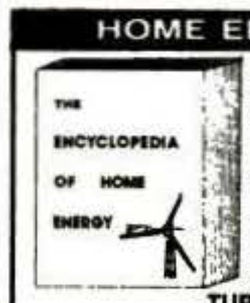

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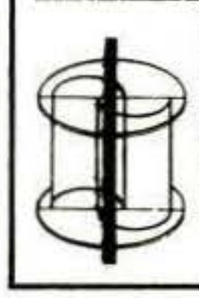

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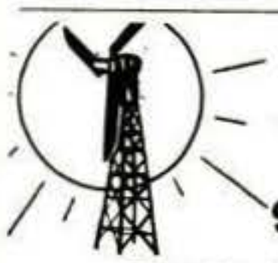

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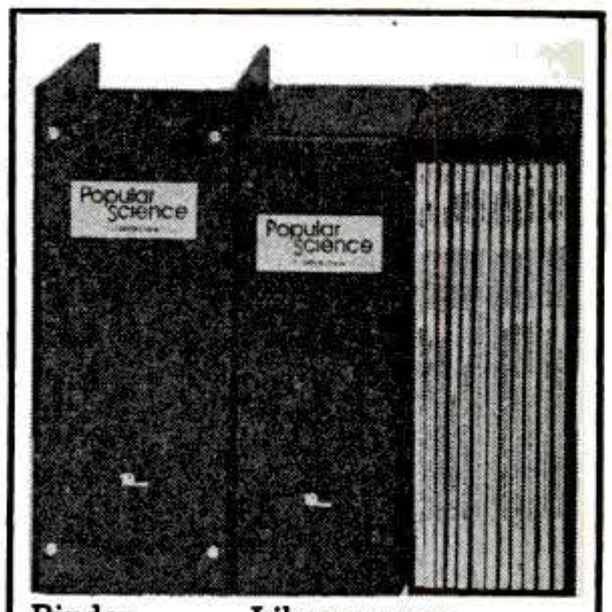

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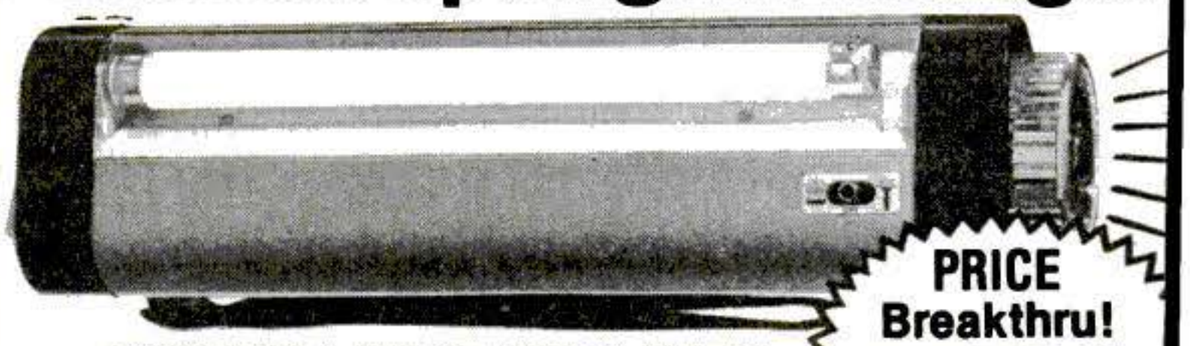

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Now...great gas mileage in a full-size truck!

Now in tough '81 Fords: the highest estimated MPG rating ever achieved by a 6-cylinder Ford Pickup. Delivered by Ford's husky 300 Six...available in F-100/F-150 models that take payloads up to 2,530 lbs.!

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F-100/F-150 with 4.9L (300 CID) Six and 4-speed overdrive option. EPA EST. MPG with std. 3-speed: 20 MPG, 27 estimated HWY.

Tough new Fords... higher ratings for 1981.

New compact rating

Even high-economy Ford Courier has improved highway mileage for '81.

27 EPA EST. MPG*† **39** EST. HWY.*†

New Bronco rating

Bronco with husky 4.9L (300 CID) Six shows 20% improvement in EPA est. MPG over last year.

18 EPA EST. MPG*† **24** EST. HWY.*†

New van mileage

Ford's business van offers even better estimated MPG for '81. 4.9L (300 CID) Six std.

19 EPA EST. MPG*† **26** EST. HWY.*†

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New truck 4.2L (255 CID) V-8 gives record-high estimated MPG for V-8 Ford Pickups.

17 EPA EST. MPG*† **26** EST. HWY.*†

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Now...20% boost over last year in estimated MPG fuel economy for tough Ford 4WD Pickups.

18 EPA EST. MPG*† **24** EST. HWY.*†

More about mileage

*Use for comparison. Your mileage may differ depending on speed, distance and weather. Actual highway mileage will probably be less than estimated. California estimates lower. All comparisons are to 1980 Ford vehicles. See your dealer for the 1981 EPA Gas Mileage Guide.

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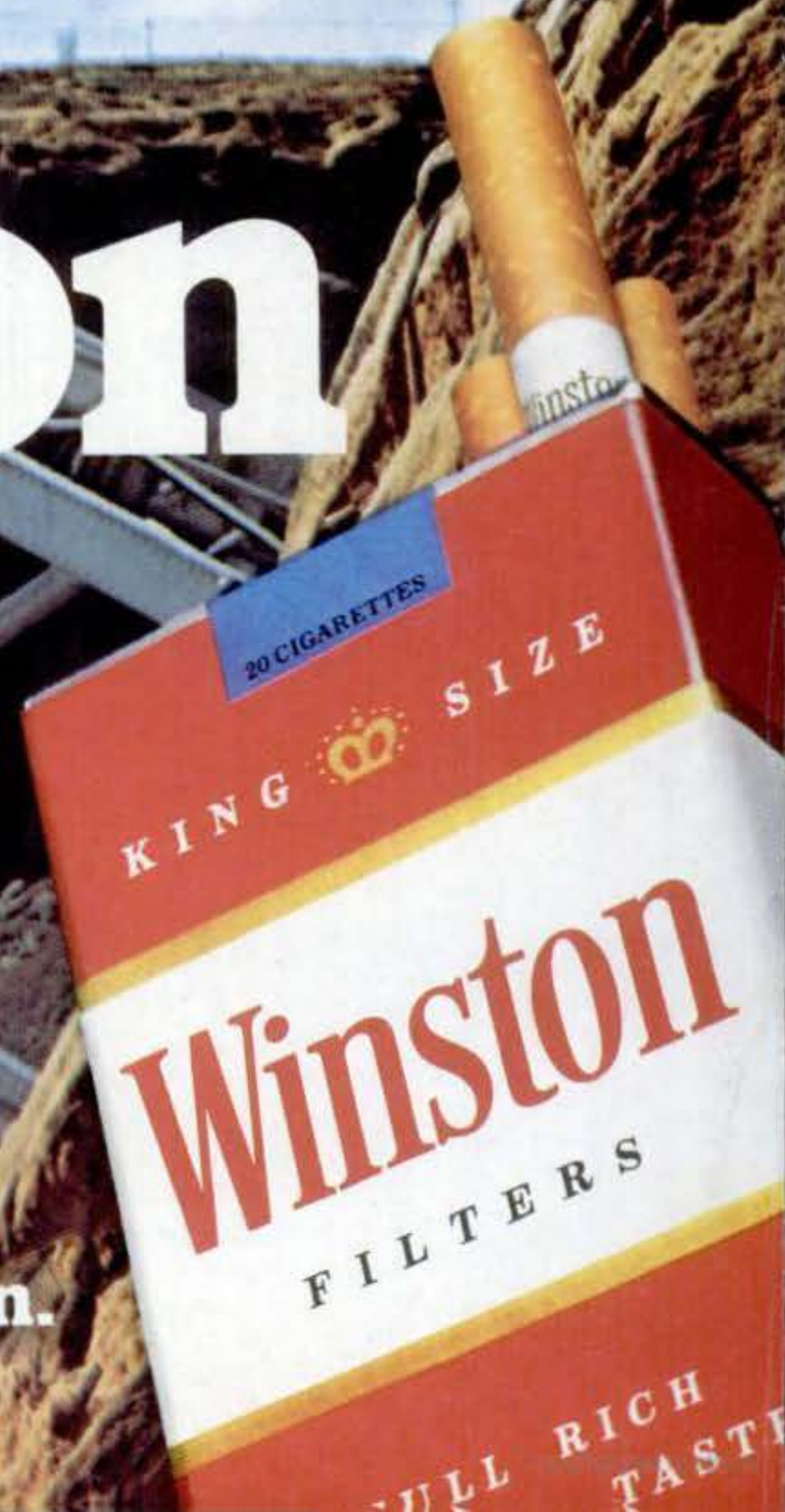

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